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DEPARTMENT OF AGRICULTURE.

BULLETIN NO. 75.

TUBERCULOSIS OF CATTLE

AND THE

PENNSYLVANIA PLAN

FOR ITS REPRESSION

BY

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With a Paper on Tuberculosis of Cattle and Its Repression in Denmark,

BY

PROFESSOR B. BANG.

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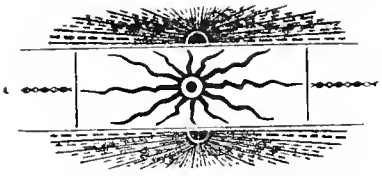

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PREFACE.

Harrisburg, Pa., January 20, 1901.

The following Bulletin on Tuberculosis in Cattle, by Dr. Leonard Pearson, Veterinarian of the Department of Agriculture and Secretary of the State Live Stock Sanitary Board, and Dr. M. P. Ravenel, Bacteriologist of the State Live Stock Sanitary Board, is an exhaustive presentation of the methods pursued in Pennsylvania for the suppression of this disease. The bulletin also contains a statement of the present state of knowledge, so far as it has been ascertained by scientific men, upon this subject.

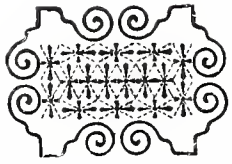
The growth of the animal industry in our State during recent years, an industry in which the citizens of Pennsylvania have now invested about one hundred and fifty millions of dollars, makes reliable information in regard to contagious diseases of extreme importance.

Tuberculosis has existed among the most valuable herds of dairy cows in the State, but through the efforts of the State Live Stock Sanitary Board, its spread has not only been checked, but the percentage of cases greatly decreased.

Our quarantine regulation, by which cattle for breeding purposes brought in from other States are required to have accompanying them certificates of health, has been a valuable aid in the control of this disease, by enabling us to keep the State free from contamination from without. A few years more of earnest and intelligent effort will clear our herds of infected animals, and make stock raising and dairy husbandry a safe business, so far as danger from tuberculosis is concerned.

The demand for information is so great, and reliable advice on contagious diseases is so difficult to procure, that the Department has had the data on the subject printed in the convenient form of a bulletin in order to meet the demand of the public in this respect.

JOHN HAMILTON,
Secretary of Agriculture.



LETTER OF TRANSMITTAL.

Harrisburg, Pa., January 20, 1901.

Hon. John Hamilton, Secretary of Agriculture:

Sir: I beg to hand you herewith a report on Tuberculosis of Cattle and the Pennsylvania Plan for its repression, that has been prepared by Dr. M. P. Ravenel and myself.

This paper gives a summary review of the facts that are established in regard to this disease and an account of the work that is done in this State to repress it.

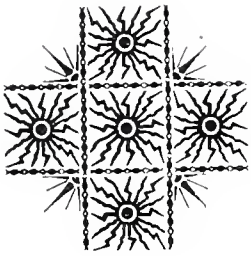
Interest in this subject is very general and there is an extensive demand for information upon it. Many of these demands can be met by brief circulars on special phases of the tuberculosis problem, but a more complete statement is desired by those who are especially interested.

As this paper comprises reports of some original work conducted under the authority of the State Live Stock Sanitary Board, I respectfully recommend that it be published as a bulletin of the Department of Agriculture under the provisions of the act of May 11, 1899.

Yours very truly,

LEONARD PEARSON,

State Veterinarian.



REPORT ON TUBERCULOSIS OF CATTLE.*

By Leonard Pearson and M. P. Ravenel.

INTRODUCTION.

There is scarcely a subject related to agriculture or public health that has occasioned as much or as bitter discussion, or has led to the expression of so many divergent views as this one of tuberculosis of cattle. For some reason, it seems to have been especially difficult for the public to reach bottom facts. The range of this discussion is well indicated when it is said that not only the existence of the tubercle bacillus but even that of the disease itself has been ridiculed and denied, while, on the other hand, the prevalence and dangers of tuberculosis have been exaggerated and distorted to false dimensions.

As a result of these extraordinary differences of statement and opinion, strong and conflicting prejudices were aroused which served to further obscure the truth and to make any action in this matter extremely difficult. Whatever progress has been made toward a settlement of the tuberculosis problem has resulted from patient, conservative discussion of the subject and more general acceptance of the demonstrated and established facts in relation to this disease. The facts in regard to tuberculosis are very impressive, if not startling, and, when presented impartially, they must arouse serious thought that will influence action.

An evil that progresses insidiously and is near at hand is difficult to recognize in its true proportions. Deaths from tuberculosis are so common that they have come to be looked upon as a matter of course. It is only during the last few decades that attention has been strongly called to the fact that they constitute a frightful drain on civilized nations and that special measures should be employed to check this avoidable waste of substance and life.

*This report has been prepared by Leonard Pearson, B. S., V. M. D., State Veterinarian and M. P. Ravenel, M. D., Bacteriologist to the State Live Stock Sanitary Board.

The parts for which Dr. Pearson is especially responsible are the introduction and chapters I, II, IV, VII, VIII, IX and X. Dr. Ravenel is especially responsible for chapters III, V and VI.

The authors have compared their work and have avoided repetition except where it was necessary to the context or to emphasize important points.

There is at this time a world wide movement that is strong and is constantly growing in strength, that is directed against the conditions that favor the perpetuation and distribution of the causes of tuberculosis. There has, no doubt, been some misdirection of energy in attempts to avoid this evil and some lack of a proper regard for the rights of property. On the whole, however, it cannot be doubted that the end in view is gradually being attained and much effective work in this direction must be expected everywhere in the near future. The world is being rescued from the "white plague."

This movement finds expression in the medical and popular literature of all countries; in special societies and congresses, some local, some international; in federal, state and local laws, and, most important of all, in the rapid diffusion of knowledge of this disease and of the weapons that are effective against it.

It is the purpose of this report to present the *facts* on the subjects covered by it; to show what tuberculosis is, what it does, how it may be prevented, and the reasons for and the character and results of the PENNSYLVANIA PLAN.

In brief, it may be said that the PENNSYLVANIA PLAN for combatting tuberculosis of cattle is based on the belief that the farmers of Pennsylvania want healthy herds and are willing to co-operate with the State to this end, provided the terms of co-operation are not more onerous than the disease itself.

CHAPTER I.

GENERAL CONSIDERATIONS.

SUMMARY.

TUBERCULOSIS IS ONE OF THE OLDEST DISEASES OF WHICH THERE IS A RECORD; BUT IT IS ONLY DURING THE PAST CENTURY, AND ESPECIALLY THE LAST THIRTY YEARS, THAT IT HAS GAINED SO MUCH PROGRESS AMONG CATTLE AS TO MAKE IT OF GREAT IMPORTANCE TO AGRICULTURE.

AT THIS TIME TUBERCULOSIS OF CATTLE EXISTS IN ALL CIVILIZED COUNTRIES, THERE ARE, HOWEVER, GREAT DIFFERENCES AS TO PREVALENCE IN DIFFERENT COUNTRIES AND IN DIFFERENT PARTS OF THE SAME COUNTRY.

THIS DISEASE IS MOST PREVALENT WHERE THE DAIRY INDUSTRY HAS REACHED ITS GREATEST DEVELOPMENT AND WHERE MANY CATTLE HAVE BEEN BROUGHT IN FROM OTHER DISTRICTS OR COUNTRIES FOR USE IN DAIRY HERDS AS MILK PRODUCERS AND BREEDERS.

IN THE UNITED STATES, TUBERCULOSIS IS MOST PREVALENT IN THE EASTERN STATES AND ESPECIALLY ON HIGH PRICED FARMS NEAR CITIES WHERE A LARGE PROPORTION OF THE CATTLE USED ARE PURCHASED. BUT THE DISEASE IS BY NO MEANS A NECESSARY CONCOMITANT OF HIGH BREEDING OR OF INTENSIVE DAIRYING.

MOST HERDS ARE INFECTED BY ANIMALS THAT, ALTHOUGH THEY ARE TUBERCULAR, APPEAR TO BE HEALTHY WHEN THEY ARE PURCHASED.

TUBERCULOSIS OF CATTLE IS STILL SPREADING AT A RAPID RATE IN MANY PLACES. THE ONLY REASON FOR THE CONTINUED SPREAD OF TUBERCULOSIS IS NEGLECT TO HEED THE AVAILABLE KNOWLEDGE OF THIS DISEASE.

IN HOLLAND NEARLY ONE-TENTH OF ALL CATTLE KILLED FOR FOOD ARE TUBERCULAR. IN BERLIN, SIXTEEN PER CENT. AND IN SAXONY THIRTY PER CENT. ARE TUBERCULAR. IN PENNSYLVANIA THE PREVALENCE OF TUBERCULOSIS IS ESTIMATED AT FROM TWO TO THREE PER CENT.

THIS DISEASE CAUSES MORE LOSSES THAN ALL OTHER INFECTIOUS DISEASES OF FARM ANIMALS THAT EXIST IN PENNSYLVANIA AT THIS TIME. THE LOSSES ARE FROM THE RUIN OR DEATH OF CATTLE; THE WASTE OF CATTLE FOOD; INTERFERENCE WITH BREEDING; TRANSMISSION OF INFECTION TO OTHER ANIMALS AS SWINE, CALVES AND GROWN CATTLE, INJURY TO THE REPUTATION OF HERDS AND THE DESTRUCTION OF THE INTEREST OF BREEDERS IN THE CONTINUATION OF BREEDING AFTER THEIR HERDS HAVE BECOME INFECTED AND SOME OF THEIR VALUABLE ANIMALS HAVE DIED.

TUBERCULOSIS OF CATTLE MAY, UNDER SOME CONDITIONS, BE TRANSMITTED TO MAN BY THE USE OF THE MEAT AND MILK PRODUCTS OF TUBERCULAR CATTLE.

THE NATURAL TENDENCY OF TUBERCULOSIS IS TO SPREAD WITHOUT LIMITATION. IT HAS SPREAD VASTLY IN EVERY COUNTRY CONTAMINATED BY IT.

IT IS ONLY BY THE INSTITUTION OF APPROPRIATE MEASURES THAT THE PROGRESS OF THIS DISEASE CAN BE CHECKED.

THE MEASURES THAT ARE NOW IN FORCE IN PENNSYLVANIA ARE SERVING NOT ONLY TO KEEP TUBERCULOSIS FROM PROGRESSING BUT TO REPRESS IT, AND AT A RATHER RAPID RATE.

SYNONYMS.

Tuberculosis, *Consumption*, *Pearl disease*, *Pining*, *Wasting*, *Phthisis*.

According to location: tubercular pneumonia, tubercular enteritis, tubercular mammitis or tubercular garget, tubercular hepatitis, tubercular meningitis, etc., etc.

HISTORICAL.

Tuberculosis is one of the oldest diseases of which there is a record, but it is only during the nineteenth century that it has reached a development and distribution among cattle that have made it of great importance to agriculture.

The Mosaic laws contain references to a disease that there is good reason to believe was tuberculosis, and it was provided that the Jews should not eat the flesh of animals suffering with it. The Talmud also contains references to diseased conditions that are supposed to be identical with tuberculosis, and provides that flesh from animals thus affected shall not be used as food.

In the tenth, eleventh and twelfth centuries, tuberculosis was described by many physicians. In Germany, church laws against the use of the flesh of animals affected with tuberculosis, were in operation in the ninth century, and a local law in Munich, in 1370, forbade the use of animals suffering with pearl disease. Similar regulations were enacted in Wurtzburg, Passau, Wurtemburg and other German cities. In 1677 it was recorded that twelve students died in Leipsig from eating the flesh of an animal that had tuberculosis. In many places the idea was prevalent during the eighteenth century that

tuberculosis was identical with syphilis and it was largely on account of this view that the consumption of such flesh was prohibited.

In 1783 the health authorities of Berlin published an opinion to the effect that syphilis and tuberculosis were not identical, and ruled that the flesh of tubercular animals could be sold in the markets. Similar opinions and regulations appeared during the following year in other German states and in Austria. These regulations continued until 1816, when Tscheulin, in Karliruhe, formulated a plan for the guidance of meat inspectors in judging flesh of tubercular cattle. He divided tuberculosis into three stages or varieties. The flesh of animals in which there were only a few tubercles on the serous membranes was permitted to be sold without restriction, after the removal of the diseased parts. If, however, the development was greater, it was provided that the diseased region should be destroyed and the remaining meat sold with a caution, at a reduced price. In cases of still higher development, the whole carcass was adjudged unfit for human food. This general plan of disposing of the flesh of tubercular animals has been followed in most of the European countries until recent times.

It is known that during the latter part of the last century, tuberculosis prevailed in Prussia among cattle to such an extent as to cause burdensome losses each year.

As tuberculosis became more prevalent and received more attention, a number of varying and conflicting opinions as to its nature were advanced. It was shown by Villemin in 1868 that tuberculosis is undoubtedly a specific infectious disease, and he produced it in rabbits by inoculating them with tuberculous material from human patients. He also produced tuberculosis by feeding tuberculous material to experimental animals, and by causing them to inhale such material. Cheuveau also, in 1868, produced tuberculosis experimentally by feeding tuberculous material to cows. These experiments were confirmed by Klebs, Cohnheim and Gerlach. The last mentioned was the first to show that tuberculosis could be produced by feeding animals the flesh and milk of tubercular cattle. As a result of these experiments, attempts were at once made to prevent the sale of the flesh of tubercular animals. Since the previous regulations respecting the sale of tuberculous meat had been abrogated for a long time, or were in force in but a few places, these attempts were met by the vigorous opposition of those financially interested.

There was, perhaps, a tendency at that time for hygienists to take an extreme position as to the danger of using the products of tubercular animals. For instance, Gerlach said: "Pearl disease is not only incurable but it renders the animal completely worthless;

meat and milk from such animals are never to be used as human food in a raw or imperfectly cooked condition."

But it must be remembered in this connection, that the early stages of tuberculosis that we now recognize were then almost unknown, and a cow that was then recognized as tubercular was in a rather advanced stage of disease. As earlier stages of the disease were recognized, the German veterinary council took a more conservative position and in 1875 rendered an opinion to the effect that experience and observation did not justify the extreme measures that were advocated by many, and the Imperial authorities were asked to furnish means for a study of the question as to whether, and to what extent, the use of the flesh and milk of tubercular cattle could be injurious to people. The results of this further study have been such as to lead to the development of the most rigid system of meat inspection that the world has seen.

The greatest step in the study of tuberculosis was made by Robert Koch when, in 1882, he discovered the true cause of this disease—the tubercle bacillus. With this great discovery the identity of tuberculosis of man and of animals was proven. From that time to the present, an immense amount of work has been done on this subject; investigators, experimenters and commissions have been studying it in all parts of the world, and hundreds of books and thousands of papers have been written on this disease and its numerous relations.

DISTRIBUTION.

At this time, tuberculosis of cattle may be found in all civilized countries. There are, however, great differences as to the prevalence or pregnancy of the disease in different places and this appears to depend largely on the length of time that it has existed in its present habitants. It seems that tuberculosis of cattle is an exceedingly old disease in central Europe, in the South German States, in parts of France and, probably, in England. It is claimed by Bang that tuberculosis of cattle was unknown in Denmark before the close of the first half of the nineteenth century, when it was introduced by cattle from Switzerland, Schleswig and England. It is also held by this authority that the cattle of Sweden and Norway have become infected from the same sources. Similar facts apply to Finland and Hungary, with the exception, however, that tuberculosis has been introduced at even a more recent time, because the disease has been known but twenty years. In Japan, tuberculosis of cattle was unknown until animals were imported from England for the purpose of improving the natives races.* In countries in which there has been no im-

* (Personal statement to the writer by Prof. Katsushima.)

portation of cattle and in which the native breeds still exist unchanged, as in many parts of Russia, Austria and Spain and in the north of Sweden and Norway and north Africa, there is but very little, if any, tuberculosis. On the island of Jersey, also, tuberculosis is rare and it is well known that outside cattle have not been imported to this island for more than one hundred years. The unimproved cattle of Mexico are known to be almost if not entirely free from this disease.

In certain parts of the United States, tuberculosis of cattle is practically unknown. The western steers that are killed in the slaughter houses of Kansas City, Omaha, Sioux City and Chicago, and those that are exported alive and killed in England are almost always free from the least traces of tuberculosis.

In some other parts of the United States the condition is quite different. Tuberculosis has been discovered in herds in all of the Eastern States and in all of the Northern States, including Montana. There are great differences, however, as to the extent of prevalence.

In Pennsylvania, tuberculosis has existed for a long time among the cattle in the eastern and especially the southeastern counties; but it has not been so prevalent as to cause alarm, or attract much attention until the last twenty-five years. The earlier agricultural reports do not refer to tuberculosis and old veterinarians, cattle breeders and butchers who have had much to do with animals, and have seen a great many of them examined post-mortem, agree that the disease has made enormous progress during this period. A very interesting and important fact in this connection is brought out by the records of the State Live Stock Sanitary Board, which show that in many parts of Pennsylvania, tuberculosis of cattle is still extremely rare or does not exist. These regions are the interior counties and valleys, many of which have been settled for a very long time. The farms in these regions are stocked with native cattle raised in the immediate neighborhood and, with the exception of a few bulls brought from distant places, the trade in cattle is all outward. It appears that these districts were stocked with cattle at a time when bovine tuberculosis was a very rare disease in the United States. Therefore, they were stocked with non-tubercular animals and as very few cattle have been introduced since, it has not happened that the disease has been imported. Similar observations have been made in reference to many scattered herds in parts of the State where tuberculosis is quite prevalent. In such districts there may be found old established herds that are entirely free from every taint of this disease. In most cases, such herds were started years ago and no animals have been added to them, excepting calves or bulls. As the percentage of tuberculosis is

considerably lower among calves and bulls than among cows of the same breeding, it has happened that the herds have not become infected, notwithstanding widespread infection in the neighborhood. That freedom from tuberculosis is not due to any other cause is indicated by the fact that in all other respects the system of herd management conforms to that practiced in the locality.

PREVALENCE.

For a number of years tuberculosis has been increasing in prevalence in every region contaminated by it, excepting in countries where stringent suppressive or restrictive measures are in operation. In Europe this is shown very clearly by the slaughter house reports. In most of the European countries all animals killed for food are examined before and after slaughter, and the careful records kept by the meat inspectors show the fact above stated.*

In Holland this is proven by the following table giving the percentages of tubercular cattle found among those slaughtered for food in Amsterdam in the years mentioned:

1888,	1.7 per cent.
1889,	2 per cent.
1890,	3.3 per cent.
1891,	5.3 per cent.
1892,	5.26 per cent.
1894,	6 per cent.
1895,	6.8 per cent.
1896,	8.12 per cent.
1897,	9.20 per cent.
1898,	12.99 per cent.

As tuberculosis becomes more prevalent among cattle it also increases in prevalence among swine, and particularly among swine fed on skim milk from creameries. This increase among the swine of Holland is shown by the following table:

1895,	1.47 per cent.
1896,	1.67 per cent.
1897,	2.31 per cent.
1898,	3.58 per cent.

* It has been said in this country that the increase in prevalence is more apparent than real and is due to a more careful search by meat inspectors for the lesions of tuberculosis. This exception shows ignorance of the methods of foreign meat inspectors. They themselves are convinced that there is a great increase in the prevalence of tuberculosis.

In Frane, Professor Nocard says, in the Departments of Brie and of Beauce, approximately 25 per cent. of the cattle are tubercular, while the cattle of Auvergne and Limousin (exporting districts), are free from the disease. Of 13,057 animals killed in the abattoir at Tolouse in 1889, 1,254, or 9.28 per cent. were tubercular.

In Bavaria, the percentage of tuberculosis was, in

1887,	1.62	per cent.
1895,	5	per cent.

In Berlin, in

1883,	2.86	per cent.
1895,	15.45	per cent.

In Prussia, of 662,164 cattle killed in 307 slaughter houses in 1895, 84,463 or 12.7 per cent. were found to be tubercular. And of 812,-731 cattle slaughtered in 1896, 107,214, or 13.2 per cent., were tubercular. In 1897, of 827,766 cattle killed, 131,325, or 15.09 per cent., were tubercular.

The following table shows the prevalence of tuberculosis among cattle killed in slaughter houses of *Saxony* in the years mentioned:

1888,	4.9	per cent.
1889,	8.1	per cent.
1890,	15.7	per cent.
1891,	17.4	per cent.
1892,	18.65	per cent.
1893,	18.26	per cent.
1894,	21.5	per cent.
1895,	27.48	per cent.
1896,	26.72	per cent.
1897,	29.13	per cent.
1898,	30.46	per cent.
1899,	29.78	per cent.

In the slaughter house at Zwickau 45.1 per cent. of all cattle killed in 1897 were tubercular.

In Dresden, in 1898, 32.21 per cent. of all of the cattle and 2.85 per cent. of all of the swine killed were tubercular.

It is instructive to note also that among the pigs killed in the slaughter houses of Saxony the percentage of tuberculosis is steadily increasing, as shown by the following table:

1890,	.84 per cent.
1891,	1.07 per cent.
1892,	1.37 per cent.
1893,	1.64 per cent.
1894,	2.2 per cent.
1895,	2.71 per cent.
1896,	2.74 per cent.
1897,	3.10 per cent.
1898,	3.16 per cent.
1899,	3.03 per cent.

In 1895, 384,473 swine were killed in 29 slaughter houses in Saxony and of these 10,450 were tubercular; that is, 2.71 per cent. In 1897, 446,480 swine were killed and 13,876 were tubercular, or 3.10 per cent. In 1899, for the first time in ten years there is not an increase in the percentage of tuberculosis among cattle and swine in Saxony.

In England, also, tuberculosis is quite prevalent in cattle; the statistics, however, are not so complete as those of Germany or of France. Of 4,321 milch cows killed in the abbatoir at Liverpool, 10.6 per cent. were tubercular. In Manchester, of 367 cattle examined post-mortem in the slaughter houses, 29.4 per cent. were tubercular. Of 11,151 cattle tested with tuberculin in 1899, 24 per cent. were found to be tubercular. Of 15,392 cattle tested in three years, 26 per cent. were tubercular. Of 80 pure bred short-horns intended for export 34, or 42 per cent., were tubercular.

In the United States no general statistics are at hand that make it possible to give tables such as the above. The observations that have been made and recorded are comparatively few and scattered, or relate only to herds known to be infected. In the slaughter houses at Chicago and Kansas City, tuberculosis is almost unknown among the cattle from the plains. There is a little more of it among the cattle from the Mississippi Valley and still more among the cows from dairies in the neighborhood of cities. In the slaughter houses at Philadelphia tuberculosis is very rare among the steers.

Most of these are from the Western States, but some are from Pennsylvania. Of those fattened in Pennsylvania, many were bred in the West. In these slaughter houses, the percentage of tuberculosis is highest among cows from the neighboring counties but, altogether, it is said that not more than 2 per cent. of the animals killed in Philadelphia are afflicted with tuberculosis in any degree. However, no complete statistical record is kept as to the inspections in Philadelphia, and as the work is distributed among about one hundred slaughter houses and but five inspectors, only two of whom are veterinarians, are engaged in meat inspection, it is evident that too much weight should not be placed on these figures.

It is observed in all slaughter houses that tuberculosis is far more common among cows than among cattle of any other class. Next in order of frequency of infection are bulls, then steers, and, lastly, calves.

The most complete statistics in reference to the prevalence of tuberculosis among cattle in the Eastern States, are based on the results of tuberculin tests of herds. Since, however, such tests are in most cases made where herds are known to be infected before the test is applied, it is evident that the figures so collected represent the extreme prevalence of tuberculosis in the worst infected places. It has been found by testing herds that the percentage of tuberculosis varies from 0 to 100 per cent. and there are instances of many large herds in which nearly all of the animals have been infected. As examples of such herds found *in Pennsylvania*, I may cite the following:

174 cattle, of which 166 were tubercular.
73 cattle, of which 59 were tubercular.
22 cattle, of which 17 were tubercular.
14 cattle, of which 14 were tubercular.
63 cattle, of which 37 were tubercular.
67 cattle, of which 37 were tubercular.
20 cattle, of which 20 were tubercular.
61 cattle, of which 45 were tubercular.
18 cattle, of which 16 were tubercular.
13 cattle, of which 10 were tubercular.
15 cattle, of which 10 were tubercular.
59 cattle, of which 53 were tubercular, etc.

These figures, of course, represent extreme and exceptional conditions. Of all the tubercular herds tested with tuberculin under the auspices of the State Live Stock Sanitary Board, about 13 per cent. of their members have proven to be afflicted with tuberculosis. When we reflect that this represents the percentage of disease in the

very worst herds in the State, it will be seen that our cattle are in a far healthier condition than those of most European countries.

From other examinations made under the auspices of the State Live Stock Sanitary Board and the results of private inspections made by veterinarians throughout the State, and such evidence as it is possible to gather from slaughter houses in the country, the cities and in small towns, I believe I am justified in saying that from 2 to 3 per cent. of the cattle in Pennsylvania are tubercular at this time.

PROGRESS.

The history of tuberculosis of cattle shows that when it is once introduced into a previously uninfected district, its tendency is to spread from farm to farm with a rapidity that depends largely upon the activity of cattle traffic. If the interchange of animals between herds is frequent, the disease usually spreads rapidly. If, on the contrary, there is but little interchange of animals, tuberculosis is characterized by a slow development in the newly infected community. This observation relates to spread among herds; other conditions govern the spread of tuberculosis after infected animals are added. The latter factor is controlled by the degree of contact between the diseased animals and their associates and the sanitary and other conditions to which the herd is subjected.

If a tubercular cow is placed in confinement with other cattle she will convey the disease to them more certainly and more rapidly than when the animals are at liberty. As bearing upon this point, it has been noted repeatedly that tuberculosis spreads more rapidly in herds when they are confined in winter than when they are at pasture in summer, and there is reason to believe that this difference is due not to the season but to the intimacy of contact. Moreover, tuberculosis once introduced, spreads with increasing rapidity as the centres of infection are multiplied. That this is the case, is shown clearly by the tables in the preceding section. So long as there is but one infected herd from which tuberculosis may spread in a district, the spread of the disease will necessarily be slow, but when ten herds are infected from this one, the progress of the disease will be ten times as rapid, and when five herds are infected from each of the ten, the disease will, other factors being equal, spread at fifty times the original rate of progress.

One reason why tuberculosis of cattle has spread by such leaps and bounds during the past few years is that it is only in very recent times that there has been a great interchange of cattle between different countries, states and localities. In the previous century, the local demands for meat and milk were met by local production, and cattle

were rarely moved long distances, excepting during time of war when needed to supply armies and devastated regions. In the early part of the nineteenth century, a certain amount of cattle traffic developed as a result of the tendency towards centralization of population, but the cattle that were moved as a result of this influence were cattle for slaughter and thus, even if diseased, did not have much opportunity to convey to other cattle such an indolent disease as tuberculosis. More recently, however, and especially during the present generation, great efforts have been made to improve cattle for special purposes, as for beef, milk, butter, etc., and this has led to the purchase of fresh blood. Moreover, railroads have increased in number and rates of transportation have been greatly reduced, so that, at present, some of the cows supplying milk for the large Eastern cities were reared west of the Mississippi river and brought east when ready for profitable use in the dairy. A very large proportion of them are raised on farms two or three hundred miles from those upon which they are established for dairy purposes. As I have stated in the previous section, tuberculosis is far more common among cows than among other cattle, therefore, there has been, in effect, a concentration of tubercular cattle from all parts towards the dairy sections that rely largely upon outside farms for their cows.

Moreover, until very recently it was not generally appreciated that tuberculosis is a contagious disease, and absolutely nothing was done to restrict its spread.

IMPORTANCE.*

In discussing this subject, exaggeration should be most strenuously avoided. Many wild statements have been made in this connection. The facts are grave enough; they should not be magnified.

The importance of tuberculosis of cattle is such as to cause the governments of the leading European countries to make most careful and searching investigations concerning it, to establish definite

*(From an article on Bovine Tuberculosis and Its Suppression, by James Wilson, M. A., B. Se., Lecturer on Agriculture, Aberdeen University. The Journal of the Bath and West Counties Society, London, 1898.)

"*The Farmer's Loss.* The great prevalence of tuberculosis among British cattle is a source of considerable annual loss to the British stock-owner. In the United Kingdom there are, in round numbers, 11,000,000 cattle made up as follows: cows and heifers in-milk or in-calf, 4,000,000; and other cattle over two years, 2,500,000; over one but under two years, 2,250,000, under one year, 2,250,000. Assuming the estimates already quoted as to the prevalence of the disease to be correct, there are 2,200,000 tuberculous cattle in Great Britain, of which number 1,600,000 are calving or milking cows and heifers. If we assume that the average time for cows to give milk is between three and four years, then the number of cows discarded annually is about 900,000, of which, since the longer a cow is kept the greater are her chances of being unsound, perhaps about 450,000 are tuberculous. But those 450,000 cows do not all go to the butcher at full value; of those that are in a more or less wasted condition when discarded, some are slaughtered and buried at home, some go the knackery, and others are bought for trifling sums either at home or in the market by dealers in precarious meat. Are we high enough when we estimate that 10 per cent. of the discarded tuberculous cows are disposed of in this way? And, if we assume that the average price of discarded healthy cows is 15 £, and that the average return for those wasted 45,000 is 3£, we have on this head an annual loss to the stock-owner of 540,000 £.

Nor do the other 405,000 tuberculous cows go to the butcher at their healthy value. The

regulations for the disposition of the flesh of tubercular animals, to introduce systems to keep tubercular cattle from entering from other countries and to expend funds in measure calculated to restrict or arrest the progress of this disease.

Tuberculosis of cattle is important in two ways: (A), it is of economic importance in relation to the live stock industry; and, (B), it is of hygienic importance in relation to the transmission of disease to consumers of meat and milk.

A. In reference to the first part of this subject, namely, *the economic importance of tuberculosis of cattle*, we may recognize several ways in which this disease works to the financial injury of owners of live stock:

1. By destroying animals outright, as when tuberculosis is allowed to reach its full development and kill its victim.

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butcher now knows that, with cows especially, he undertakes whatever risks arise from more or less efficient meat inspection, and against this he has to insure himself at the time of purchase. Are we beyond the mark in estimating that not only these 405,000 tuberculous cows, but also the 450,000 sound cows would fetch other twenty shillings a-piece if the butcher were sure of their carcasses being fit for human consumption. On this second head we have a loss of 855,000 £ to the stock-owner.

Nor is this all: One of the results of ill-health with the cow is a diminution in the quantity and a deterioration in the quality of the milk. This is seen not only in the dairyman's pail, but also in the ill-thriven calves of the stock-raiser who has them brought up by their tuberculous mothers in Nature's own way. And of the 1,600,000 tuberculous cows, would it be too much to assume that a fifth of them, which is slightly more than half the number of tuberculous cows annually, are giving an impaired return either to the dairyman or to the stock-raiser? Indeed, is not an impaired return the usual cause of a cow being discarded and are not healthy cows at their best about the fifth or sixth year of lactation? And, while some cows are giving a highly impaired return, although the return of others is only slightly affected, would the estimate be too high that on the average the return of the 300,000 cows is affected to the extent of one-quarter? Then, if we assume that the average annual return from cows in this country is 12 £, we are met with a loss on this head of 900,000 £.

Nor is this yet all: There is another loss that is felt perhaps but slightly in the case of dairy cows, but which is felt in the case of suckling cows above the average value and in the case of cows retained for pedigree breeding. The cause of this loss lies in the fact that tuberculosis, in many cases, affects the reproductive organs of the female with the result that the animal produces an abortion or becomes an uncertain or even a non-breeder. How often at a stock-breeding farm do we find animals that are not in-calf but are kept on, merely eating their meat, for months and even occasionally for years, in the hope that they may yet be fortunate enough to produce a calf. And how often at sales, do we see cows that are declared to be uncertain breeders, and others again that have been mated just a few weeks previously. The number of cows in this condition may not be so very many, but then the cost of their keep is a matter of some moment. Suppose we say that one in thirty of all tuberculous cows are affected in this way and that the average time lost by each is three or four months—remembering that this trouble is more serious among suckling cows than among dairy cows, and that the "in-calf" cows that are not in-calf passing from one man to another help to swell the average loss in time—then we have 53,000 cows—reckoning their average annual cost at from eight to ten pounds—causing an annual loss of 150,000 £.

Our computations so far amount to 2,445,000 £, which is all incurred through cows alone; but we have yet to add to this the loss expected from other cattle. Since, however, other cattle are affected, perhaps only to a fifth or a fourth the extent that cows are—20 per cent. of all cattle affected and 40 per cent. of cows leaves about 8½ per cent. of cattle other than cows affected—since also they are usually sent to the butcher before their condition is nearly so bad as that of cows, and since the losses on their account are incurred only through impaired feeding and an occasional death or seizure at the hands of the public health officers—perhaps also through the butcher insuring himself at time of purchase—the sum to be added to our two and a half millions must be proportionately smaller. Our loss upon cows and upon calving heifers works out at twelve and sixpence a head. If we say that our losses upon all other cattle are only one-tenth as much per head, then they amount to 437,500 £.

Our sum total is now 2,882,500 £. But to this have to be added those losses that can scarcely be estimated, from derangement of the stock-keeper's business, from forced sales, and, therefore, from purchases at unfavorable times, from unexpected expenses, from litigation, and so on. We are probably not much beyond the mark if we reckon the total annual loss from cattle alone to the British farmer and stock-owner at 3,000,000 £ ($15,000,000.00)."

2. By reducing the market value of the animal, as in those cases in which the beast is sold before the disease has reached such a stage as to render it entirely unmarketable.

3. By reducing the breeding value of a herd and its general productivity.

4. By causing a waste of cattle food through feeding it to animals that cannot give an adequate return.

5. By infecting other animals, swine, calves, grown cattle, through the milk or by contact.

6. By injuring the reputation of a herd, thereby rendering it difficult to dispose of the animals or their products.

7. By destroying the enthusiasm or interest of the breeder in the maintenance of his herd at a high standard.

In respect to the first two of these points, it may be said that careful statistics gathered in Germany (Siedamgrotzky) show that the cattle industry there is taxed to the extent of 6,762,660 marks per year, as a result of condemnation of carcasses and destruction of parts of carcasses, etc., in slaughter houses; and these figures do not begin to represent the total loss from tuberculosis in that country which are estimated by Renneberger to amount to more than 90,000,000 marks annually. This is probably a conservative estimate. It is recognized that tuberculosis injures the live stock industry in Germany to a far greater extent than any other pest, and this includes such exceedingly virulent affections as rinder-pest, lung plague, foot-and-mouth disease, anthrax, etc.

In a recent paper by Professor Siedamgrotzky, one of the chief medical advisers of Saxony and State Veterinarian, attention is called to the above figures, and to other ways in which tuberculosis causes loss; to the danger to consumers of the meat and milk of tubercular animals, and the fact that this same disease is spreading at a rapid rate among swine as a result of feeding them skim milk. The paper contains the following clause: "This exhibit has shown that tuberculosis of cattle causes serious losses that are constantly increasing, to cattle owners and, indeed, to the whole agricultural interest. It threatens the swine industry and the public health, and it is necessary that it should be combatted energetically without delay."

Of course, the losses caused by tuberculosis are in ratio to its prevalence, and it follows that they are proportionately less in the United States than in Germany.

In parts of this country where tuberculosis has prevailed so long that cattle owners have become quite familiar with its manifestations, it is the practice to sell suspected animals. In this way total loss is avoided but, naturally, as the animal sold is in bad condition, only part of its health value can be obtained. Moreover, any saving that

the owner may effect in this way is, unless the animal is killed in an inspected slaughter house, at the risk and expense of public health.

When a herd becomes extensively tuberculous, there are always some barren cows in it that are in heat much of the time, the source of much annoyance, and can give no adequate return for the food and attention they receive. Abortion also results from tuberculosis in some cases. When cows that are extensively diseased bear living calves, the offspring are apt to be weak and unprofitable.

In many cases tubercular cattle are kept for a long time while in an unthrifty condition and before it is known that they are thus diseased. In such instances they receive extra feed and care in the attempt to restore them to health. Not only is the feed wasted and the time-consuming care thrown away, but the animal is constantly scattering germs of disease that may infect other cattle.

There are numerous instances and, indeed, a large number have come to my attention in Pennsylvania, where farmers have been completely ruined by the ravages of this disease and more that would have been ruined if it had not been for State aid. Consider the case of a farmer who rents his farm, whose business is dairying, and whose income is derived from the sale of the milk from, perhaps, twenty cows. If his herd becomes extensively infected with tuberculosis and this fact becomes known, he is at once deprived of a market for his milk, he cannot sell his cows to other dairymen and his only method of disposing of them is to sell them to the dealers who make a business of buying such stock, and always at a low figure. If it does not become known that his herd is infected with tuberculosis and he continues in the milk business, the frequent development of advanced disease among his cows, thus destroying them for dairy purposes, or their death and the diminished productivity while on full rations, will eat up his small margin of profit and in time become so extensive as to cause a steadily increasing deficit.

Another serious loss that results indirectly from the prevalence of tuberculosis in cattle is the restriction in the consumption of milk that is induced by the fear that milk purchased may come from tuberculous herds. That there is a widespread feeling of insecurity among milk consumers is shown very clearly by the fact that physicians almost universally advise the use of Pasteurized or sterilized milk for infant feeding and also to a large extent for invalids. It is also shown even more clearly by the fact that many of the most extensive dealers in milk have found that their market has improved when they introduced an examination of the herds supplying them with milk and guaranteed the health of the cattle. Several large milk businesses have been developed on this guarantee. The creameries of the State generally refuse the milk of herds that are known to be tuberculous.

There can be nothing more discouraging to a breeder of cattle, who has devoted a great deal of time, the better part of his life, perhaps, and much of his means, to the development of a particular breed or strain, than to see his valuable herd ruined by tuberculosis. If this occurs, it will be noticed at first that some of the old cows in the herd will cough obstinately or become thin while continuing to eat well; their condition will gradually go from bad to worse until they are destroyed. Similar symptoms will develop in some of their associates and if the disease is not recognized in time and the necessary precautions taken, the infection will become extensive in the herd, the percentage of deaths will increase each year and may amount finally to from 10 to 20 per cent. of the entire herd annually, and it is then impossible to derive any advantage from the maintenance of the animals. The history of many breeding herds that were once famous and of great value, is expressed in the above.

B. As to the public health importance of tuberculosis of cattle, I shall say but little, because this subject is discussed in greater detail in another part of this bulletin. It is enough to say here that tuberculosis of cattle and tuberculosis of man are caused by the same germ, which may be transmitted from animals of one species to the other, and reproduce this disease. It has been shown by a great many thoroughly trustworthy experiments that the milk of tubercular cows practically always contains the germs of tuberculosis where there is udder tuberculosis; frequently where there is generalized tuberculosis, and sometimes when the udder is healthy, so far as can be determined by examination during the life of the animal, and the disease is not advanced in the cow to such an extent as to make it possible to recognize it by physical examination. On the other hand, it is true that the great majority of tubercular cows do not furnish tuberculous milk until they have reached quite an advanced stage of disease, but in a herd of tubercular cows in all stages of disease it is common to find that some of them are producing tuberculous milk and the mixed milk of the herd is then dangerous.

Another way in which tubercle bacilli may enter milk has been brought to light by Eber. It has been shown that the dust of stables in which tubercular animals are kept, frequently contains these germs; they are also in the manure. During the act of milking, many of these particles enter the milk and may thus infect it, although it comes from a healthy cow. That milk containing tubercle bacilli is dangerous is shown clearly by the prevalence of tuberculosis among swine fed skim milk from tuberculous herds, and among calves reared on such milk. Moreover, there are cases on record that show beyond peradventure that tuberculosis has been conveyed from cattle to man by direct accidental inoculation, proving that under such conditions human beings may contract tuberculosis from cattle.

There are also numerous observations (see Chapter III), that indicate that tuberculosis has been conveyed to people through the meat or milk of tubercular animals. Direct proof of such transmission is sometimes demanded; it is not possible, however, to furnish many direct demonstrations of infection of human beings through the consumption of the meat or milk of tubercular animals, and it is not to be expected that such proof will ever be furnished in great quantity. There are so many possible sources from which an individnal may contract tuberculosis that to say the disease has been acquired from a certain one is as difficult as to indentify the particular gnn that fired a fatal bullet when a soldier was exposed to the fire of more than one. Such direct proof can only be based on experiments similar to those performed upon animals and of course such experiments will never be made. When an animal is subjected to a feeding experiment to determine the virulence of a given food, it is deprived of all food that can possibly contain the germ of tuberculosis excepting the food that is being tested and that is given under careful precautions against external contamination; moreover, the animal is protected from all other sources of infection. It is known that it is free from tuberculosis to start with, and if it develops tuberculosis, there is every reason to believe that such disease results from the food intentionally administered.

In the case of human beings, it is known that a very large proportion of all deaths (in Philadelphia one in ten), are caused by tuberculosis. Lesions of tuberculosis are sometimes found in such development and distribution as to indicate that infection was through the digestive tract. It can often be shown that these individuals consumed the products of tubercnlar animals and the collateral history of the case may be such as to strongly indicate that infection occurred from such source, but as the person was not subjected to the fixed conditions governing the experimental animal, and as the possibility of infection through some other unguarded channel can not be disproven, the absolutely complete proof of infection by animal products in isolated cases is difficult to establish. But it is just as exact to say that absolutely complete proof of infection from houses occupied by consumptives and from consumptive associates has not been furnished, although the evidence of such infection is so strong that it cannot be doubted and is believed by all who have carefully studied this disease.

To recapitulate: since it is known that tubercle bacilli from cattle are virulent for man, that the products of tubercular animals sometimes contain germs of tuberculosis, that these products when fed to experimental animals will produce tuberculosis, that in such cases the disease shows a distribution and development indicating the channel of infection, that similar products are consumed by people and that lesions

of tuberculosis in man (especiallg in children), are not rarely distributed as in animals infected under fixed conditions in feeding experiments, and develop when causes other than infected milk do not appear, there is ample reason for the belief that the products of tubercular cows may cause tuberculosis in man.

As against this view, attention has been called to the fact that while tuberculosis in man is decreasing in prevalence, tuberculosis in cattle is increasing, and it has been stated that if it is true that tuberculosis of cattle is an appreciable source of infection for man, the statistics would be different. It should be remembered, however, that no one claims that tuberculosis of cattle is the principal source of infection for man. It is only an occasional source of infection for adults and it is thought to operate most frequently in infants living, as they do, in large part on milk diet. To argue that since tuberculosis is becoming less prevalent among people and more prevalent among cattle, therefore tuberculosis of cattle can have no causal relation to tuberculosis of man, will be like an argument to the effect that because the level of water in a certain pond fed by several springs is gradually falling, therefore the pond cannot receive a supply from one special spring.

In another connection, Prof. J. L. Laughlin makes use of the following illustration: "It is as though a block of wood on the floor were acted on by two opposing forces, one tending to move it forward, one backward: If it moves backward, that does not prove the absence of any force to move it forward, but only that the other force is the stronger of the two, and that the final motion is the resultant of the two forces. It is only near-sighted generalization to say that since the block moves forward, there is therefore no opposing force to its advance."

It is shown by the statistics in the General Register Office of England, as quoted by The Royal Commission on Tuberculosis, which reported to Parliament in 1898, that the percentage of tuberculosis among the people of England and Wales has steadily diminished during the period from 1851 to 1895. In fact, during this period of 45 years there has been a diminution of 39.1 per cent. in the deaths from tubercular disease in all of its forms and at all ages.

The following quotation is made from page 3 of this report, as it seems to be of special interest in this connection.

"For the age period 0 to 5 years, there has also been a reduction in death from tubercular disease in all forms from 5,764 per million living at that age in 1851 to 1860 to 4,155 in 1891 to 1895, a diminution of 27.9 per cent. This reduction is, however, but little more than half that which has taken place in the age periods 15 to 20 years and 20 to 25 years; and when we come to examine that form of tubercular disease, namely tabes mesenterica, which is believed to be mainly

due to infection received by the digestive tract, we find that whilst at the age period of 0 to 5 years, when milk forms so important an article of diet, the rate of death per million living has shown, first increase, then decrease, yet the rate which stood at 1,625 during 1851 to 1860 had only fallen to 1,577 for the period of 1891 to 1895, a diminution of but 3.0 per cent. In this connection we feel it necessary to recall the fact that the term tabes mesenterica, as used in our death records, is very indefinite, and that it has comprised, and doubtless still comprises, a considerable amount of death from certain diarrhoeal affections which are not really tubercular. But whilst this is so, it must also be remembered that the rate of mortality from tabes mesenterica which, more than any other, represents tuberculosis in infancy, has signally failed to undergo any noteworthy diminution during the very period of sanitary progress which has been associated with such substantial diminution of death from tubercular affections at all ages in England and Wales, and that this result has coincided in point of time with a large increase in the consumption of milk."

Moreover, at one period of life, before the end of the first year, when the child is on an almost exclusive milk diet, there has been an actual increase of tabes mesenterica of no less than 27.7 per cent. (Sir Richard Thorne.)

If children contract tuberculosis solely, or even chiefly, from adults one would expect the prevalence of tuberculosis among them to fall in a ratio proportional to the ratio of diminution of tuberculosis among their elders. Since this is not the case and since houses are much improved as to sanitary conditions it is strongly indicated that children are infected with tuberculosis from some source outside of their families and homes.

TENDENCY.

Tuberculosis of cattle is a disease against which it is as yet impossible to protect an animal by vaccination or inoculation. It is a disease which runs a chronic course with but little tendency to heal, although it is sometimes latent for a long period. Even if the animal recovers, it is not thereby rendered immune to another attack as is the case with hog cholera, anthrax, influenza and numerous other diseases. Therefore, when tuberculosis is introduced into a herd it is not self-limiting and its tendency is constantly to spread and with a degree of rapidity that depends largely upon the sanitary conditions to which the herd is subjected. If these conditions are favorable to the spread of tuberculosis, its distribution will be rapid. If, on the other hand, the conditions are unfavorable to such spread, the progress will be proportionately slower. If the conditions are so very unfavorable for the progress of disease that it cannot spread as rapidly as the animals are changed in the herd by the replacement

with young of those sold, only under these conditions will the disease disappear without the employment of special measures directed against it. The conditions that are least favorable to the spread of tuberculosis and under which this form of natural suppression may occur, do not exist in the Eastern States or in dairy districts. They are found only upon the plains of the west and in a few stables of special construction. The whole history of the disease and its course in dairy countries into which it has been introduced up to this time shows that it has no tendency to become less virulent or to gradually die out, but, on the contrary, it steadily reaches out for new victims.

Without control, we have every reason to expect tuberculosis to become as prevalent and destructive among the live stock in this country as it is in the old infected regions abroad, where in large districts from one-half to two-thirds of the cattle are infected and where in some countries, as in the Kingdom of Saxony, thirty per cent. of the cattle killed for food are found to contain alterations of this disease.

The fact that tuberculosis has gained such extreme headway in some parts of Pennsylvania as is indicated by the figures on p. 21, shows that conditions exist in Pennsylvania that are favorable to its progress. There is no reason to doubt, and analogy furnishes us with every reason to believe, that if the spread of tuberculosis is not restricted here it will become fully as prevalent and destructive as it is in any foreign country.

When tuberculosis of cattle was introduced into many of the countries of Europe, and while it was gaining a foothold, there was little knowledge as to the cause of the disease and its mode of transmission, and less as to its recognition. Hence, repressive measures were not possible until after many herds were saturated with disease and large districts infected. *We now have the advantage of knowing both the enemy and the means to be employed in combatting it, and if tuberculosis shall ever become more firmly rooted in Pennsylvania it will be because the lessons of experience are unheeded and available protection ignored.*

It will be shown later that it has been possible for the State Live Stock Sanitary Board not only to keep tuberculosis from making progress, which in itself is a difficult achievement, but also to materially reduce its prevalence among Pennsylvania cattle; for there is ample reason to believe that there is considerably less tuberculosis in Pennsylvania now than there was four years ago. Since the disease has gained such a strong foothold it would appear that if the preventative and suppressive measures authorized by this State and conducted by this Board had been delayed, the extension of tuberculosis at this time would be considerably greater than it was in 1896.

CHAPTER II.

THE CAUSE OF TUBERCULOSIS AND THE INFLUENCES THAT GOVERN ITS SPREAD.

SUMMARY.

TUBERCULOSIS IS CAUSED BY A GERM KNOWN AS THE TUBERCLE BACILLUS; THIS IS THE PRIMARY, ESSENTIAL CAUSE OF TUBERCULOSIS. ANYTHING THAT FACILITATES THE ACQUIREMENT OF TUBERCLE BACILLI BY ANIMALS OR ANY INFLUENCES THAT TEND TO BRING ANIMALS INTO A CONDITION MORE FAVORABLE FOR THE GROWTH OF TUBERCLE BACILLI, MAY BE CALLED SECONDARY OR ACCESSORY CAUSES OF TUBERCULOSIS.

TUBERCULOSIS IS GENERALLY BROUGHT INTO A HERD BY A COW THAT HAS BEEN A MEMBER OF A TUBERCULOUS HERD AND HAS CONTRACTED TUBERCULOSIS BUT DOES NOT YET SHOW SYMPTOMS OF DISEASE.

EVERY ANIMAL FROM A TUBERCULOUS HERD OR FROM AN UNKNOWN SOURCE SHOULD BE REGARDED AS SUSPICIOUS AND SHOULD BE TESTED BEFORE IT IS ADDED TO A HERD OF HEALTHY CATTLE.

TUBERCULOSIS IS ALSO CAUSED BY THE MILK FROM TUBERCULAR COWS. HERDS ARE SOMETIMES INFECTED BY THE SKIM MILK RETURNED FROM CREAMERIES. MIXED SKIM MILK SHOULD BE HEATED BEFORE IT IS USED FOR FEEDING PURPOSES.

AFTER TUBERCULOSIS HAS ENTERED A HERD, THE RAPIDITY WITH WHICH IT SPREADS DEPENDS UPON THE CHARACTER OF THE STABLE AND THE CARE GIVEN TO THE ANIMALS. THE CONDITIONS THAT ARE MOST FAVORABLE TO THE SPREAD OF TUBERCULOSIS ARE: CLOSE CONFINEMENT, WITHOUT EXERCISE, IN A CLOSE, POORLY LIGHTED AND BADLY VENTILATED STABLE—IF THE STABLE IS DAMP IT IS STILL WORSE—DIRT, DUSTY ATMOSPHERE AND INADEQUATE OR INAPPROPRIATE FEEDING.

THE CLOSER THE CATTLE COME IN CONTACT WITH EACH OTHER THE GREATER THE DANGER WHEN SOME OF THEM ARE TUBERCULAR.

THE CONDITIONS THAT RETARD THE SPREAD OF TUBERCULOSIS THROUGH A HERD ARE: FRESH AIR (GOOD VENTILATION), EXERCISE, LIGHT, CLEANLINESS, A BALANCED RATION OF GOOD FOOD, ABSENCE OF DUST IN THE STABLE ATMOSPHERE AND PARTITIONS SEPARATING THE STALLS AND MANGERS, THUS KEEPING THE COWS APART.

HOWEVER GOOD THE CONDITIONS OF STABLING AND MANAGEMENT MAY BE, THE SPREAD OF TUBERCULOSIS CANNOT BE CHECKED ALTOGETHER IF TUBERCULAR COWS ARE PERMITTED TO REMAIN AS MEMBERS OF A HERD AND OCCUPY A PART OF A STABLE WITH HEALTHY COWS.

UNDER SOME CONDITIONS, TUBERCULOSIS MAY BECOME STATIONARY IN A DISEASED ANIMAL AND REMAIN STATIONARY OR LATENT FOR A LONG PERIOD. THIS RESTING STATE MUST NOT BE CONFOUNDED WITH RECOVERY BECAUSE THE LESION MAY BLAZE UP AT ANY TIME AND PUT THE ANIMAL, IF IT WERE NOT BEFORE, IN A CONDITION RENDERING IT DANGEROUS TO ITS ASSOCIATES.

The primary cause of tuberculosis is the tubercle bacillus. Without this germ, tuberculosis cannot exist and the disease only arises when this organism is carried into and multiplies in the tissues of an animal. The characteristics of this organism are described in detail in another part of this report. The tubercle bacillus is as strictly essential to the development of the disease tuberculosis as a seed is for the development of a plant. The tubercle bacillus is the primary, essential cause of tuberculosis.

Anything that facilitates the acquirement of tubercle bacilli by animals or any influences that tend to bring animals into a condition more favorable for the growth of tubercle bacilli may be called secondary or accessory causes of tuberculosis.

HOW TUBERCULOSIS IS CARRIED INTO A HERD.

The seeds of tuberculosis may be brought into a healthy herd in a variety of ways. The most common method is by the introduction of a tubercular animal. As is described elsewhere, the diseased areas in tuberculosis may be located in any part of the body. If so located that they communicate with the exterior through the air passages, the digestive tract, the kidneys, the udder or the genital organs, it is possible for the broken down tissue and tuberculous material containing bacilli to be eliminated from the body of the living, diseased animal. After reaching the exterior and coming within reach of a healthy animal this material may be inhaled, it may be eaten or drunk; it may be introduced into the genital passages of a cow during the act of service, or it may reach an abraded surface on the skin and, in any of these cases it may penetrate, multiply and produce tuberculosis. Of these methods of infection, inhalation and ingestion are, by far, the most common. A healthy herd or a healthy animal may become infected by placing it in premises previously occupied by tubercular animals. The bacteria are able under certain conditions to live for a long time outside of the animal in which they develop. Thus stables may be contaminated by them and when a healthy cow is placed in such a stable the germs may gain access to her body.

Tuberculosis has also been carried to healthy herds in the milk of tubercular cattle. Such milk fed to calves will give rise to tuber-

culosis and numerous instances are known in which herds have become infected by the skim milk from creameries supplied by a large number of producers, some of whom have tubercular herds.

The mixed skim milk returned from the creamery to a healthy herd may be contaminated. This danger is so great that in some places (parts of Pennsylvania and New England, France and Germany), it is the practice to heat skim milk to a temperature that will insure the destruction of the tubercle bacillus. In Denmark and Prussia such heating of skim milk and buttermilk is required by law. Several illustrations of this danger have recently come under my observation. In one case, a large herd was tested with tuberculin and it was found to be extensively diseased. Two of the cows had tubercular udders. This herd was used for the production of cream that was shipped to market, the skim milk being retained for feeding calves. It was the practice on this farm to remove the calves from their dams when they were three days old and keep them in a separate building distant from the cow stable. The dairy building and separator were located midway between the cow stable and the calf stable. After the cream had been separated, the skim milk was carried on for the calves. When the cows were tested the calves also were examined and it was found that while the prevalence of tuberculosis among the dairy cows was 75 per cent., all the calves reacted and were condemned. The post mortem examinations of the calves revealed tuberculosis of the post pharyngeal lymphatic glands or lower digestive tract in all cases, indicating that infection had occurred through the digestive system and that it had been carried to these calves in skim milk.

Swine may contract tuberculosis by feeding upon milk of tubercular cows, or, as is often the case, by eating the offal of tubercular animals that is removed from slaughter houses. The sticky residue that is found in the bowls of separators contains great numbers of milk bacteria, and tubercle bacilli if the separated milk originated from tuberculous herds. Hence, the use of this material for any feeding purpose is dangerous. It has been shown by Ostertag that swine kept at creameries and those to which this material is fed are tubercular in a high percentage of cases. Danger from feeding this material is recognized as so urgent in Denmark and Prussia that creamery operators are required to burn it.

Another possible way in which tuberculosis may be carried to a healthy herd is by means of the fodder that has been stored above a stable in which tubercular cattle were housed. It is well known that where the stable is occupied by tubercular animals, the dust may contain tubercle bacilli and that such dust is carried by the air, and it may thus contaminate the fodder stored within easy reach. I

know of no case in which it has been shown that infection has been carried by this means, but the danger is possible and the point is one that deserves consideration.

In addition to the modes of infection above noted, it is possible that in some exceptional cases cattle may be infected by a tubercular attendant. It is certainly true, however, that such infection is very rare under any conditions and the conditions under which it is possible (where the stable is also used as a dwelling) are almost unknown in the United States.

From the practical standpoint, the danger to which the greatest attention should be paid is that resulting from the introduction of a tubucular animal into a previously healthy herd. This is the way in which infection is started in most cases. It is probably safe to say that nine-tenths of all tuberculous herds are infected by cows that looked healthy when they were purchased. The fact that a cow even extensively infected with tuberculosis may show no symtoms of disease, makes all cattle suspicious if they are known to come from an infected herd or if their origin is unknown.

THE INFLUENCES AFFECTING THE SPREAD OF TUBERCULOSIS IN A HERD.

Having briefly considered the way in which tuberculosis may enter a herd, let us consider the conditions which govern the distribution of the germs among the members of the herd and that influence the resistance of animals to their development.

The liberation of infectious material from the tubercular animal.—The methods by which infectious material may pass from a tubercular cow to one in close association with her have been explained by different writers. It has been shown that tubercle bacilli are carried in the coughed-out material that is either projected directly into the food of the other animal or is deposited within reach so that it may be licked up and swallowed or so placed that it can dry and its dust be inhaled. It is also possible for tubercle bacilli to be carried by the minute drops of fluid that are projected from the respiratory passages during the act of coughing, bellowing or other forced expiration. These were the only methods of communication that were generally recognized until quite recently.

When it was suggested that the saliva might be infectious it was thought by many that this was scarcely probable because the tubercular cow is supposed to swallow most of her expectorations, thereby interfering with infection of the mouth fluids. It should be remembered, however, that in rumination, the bolus of food passes from the stomach to the mouth and may carry into the mouth expectorated

material that has been passed up the trachea into the pharynx or that has adhered to the wall of the oesophagus and even material that has entered the stomach. Furthermore, in the act of coughing, some of the infectious material from the respiratory tract must lodge in the mouth and in this way, again, the saliva may become contaminated. To test this question, an apparatus was designed for collecting sputum, so that it might be examined bacteriologically. The apparatus consists in a deep bag covered with canvas, lined with enamel cloth and supported by an iron frame. This bag is placed over the muzzle of the cow as a nose bag, sputum collects in the bottom of the bag, or it may be placed on a piece of absorbent cotton or on a wooden diaphragm placed in the bottom of the apparatus. The bacteriological examination of this material by Dr. Ravenel shows that in some cases the sputum contains tubercle bacilli. Where this method of collection is tried on a coughing cow the material gathered will be composed of sputum and particles projected from the air passages as well, but where the cow does not cough, only the sputum that drops from the mouth is collected.

The examination of material collected under both conditions has shown the presence of virulent tubercle bacilli. With this information we can appreciate the danger to which a healthy cow is exposed when she licks up food from a surface from which a tubercular cow also eats. It is also shown that danger must attend the licking of a healthy cow by a tubercular one, for the healthy cow will, sooner or later, lick a part of the same surface, and then take into her mouth bacilli deposited by the diseased cow.

The danger of direct infection from the inhalation of expired air of a tubercular cow is probably not very great, as is shown by the following experiments. A long nose bag or respirator with a stiff iron frame was made with two bottoms three inches apart. These bottoms were made of wire cloth with a one-third inch mesh. One bottom was fixed three inches from the lower end of the frame and about six inches from the cow's nose when the bag was in position on the animal. The other bottom was movable and flush with the end of the frame. A guinea pig could be placed in the space between the two wire cloth partitions and while thus confined all of the air breathed by the cow would pass through the compartment occupied by it. In this way a guinea pig could be surrounded by and exposed to the expirations of a tubercular cow for any desired length of time. In this apparatus, however, it was possible for the cow to cough directly on the guinea pig and it was thought that infection might be produced by solid particles expelled in this way. To avoid this possibility and to expose the guinea pig only to the breath and particles floating in it, a modified respirator was constructed

in which the guinea pig was placed at a higher level, out of reach of solid particles expelled by coughing, and the air current was directed upward, by having the frame bent, open above and closed below. As is shown by the following table, twelve guinea pigs were exposed in some one of these respirators for periods varying from $2\frac{1}{2}$ to 26 hours and none of them was infected.

BREATH EXPERIMENT.

Date.	Number of animal.	Subject exposed on.	Length of exposure, hours.	Died or killed.	Results.
April 18,	1	Cow No. 3	3	July 11,	No tuberculosis.
April 18,	2	Cow No. 3	3	July 11,	No tuberculosis.
April 19,	3	Cow No. 3	5	June 18,	No tuberculosis.
April 19,	4	Cow No. 3	5	June 18,	No tuberculosis.
April 21,	5	Cow No. 1	2½	June 13,	No tuberculosis.
April 21,	6	Cow No. 1	2½	July 11,	No tuberculosis.
April 26,	7	Cow No. 2	3	May 9,	No tuberculosis.
May 5,	8	Cow No. 5003	11	July 11,	No tuberculosis.
May 11,	9	Cow No. 5986	15	July 12,	No tuberculosis.
May 11,	10	Cow No. 5986	15	July 12,	No tuberculosis.
May 23,	11	Cow No. 5986	26	July 19,	No tuberculosis.
May 23,	12	Cow No. 5986	26	July 19,	No tuberculosis.

Some of the cows used in this experiment were suffering with advanced tuberculosis of the lungs and tubercle bacilli were found in their sputum and saliva. Guinea pigs fed the sputum from some of these same cows died of tuberculosis.

A tubercular animal in a herd is dangerous in proportion to the number of tubercle bacilli it excretes. The quantity of tubercle bacilli excreted by tubercular animals depends upon the stage, location and extent of the alterations. Until death of tissue occurs, the diseased parts do not separate from the living body and the infected tissue debris cannot be thrown off. Where the lungs are involved, the cow may cough out particles of diseased material and, as has been shown, her saliva is infectious in such cases. Therefore, she can then deposit germs during the act of eating, drinking, licking and by the forcible expiration of bellowing as well as by coughing.

The faeces are also infectious when lesions are located in the digestive or in the respiratory tract. It has been shown by Cadeac and Bournay that tuberculous material is not rendered non-virulent by the digestive juices of the cow and the feeding of infectious material is followed by the appearance of virulent germs in the faeces. Therefore, the expectorations from the diseased lungs that are carried

up to the throat and then swallowed serve to render the manure as well as the saliva infectious. No doubt, some earlier investigators have mistaken the acid-resisting bacillus of Möller for the tubercle bacillus because this organism occurs in hay and manure and has been identified but recently; but there are enough unquestionable returns to prove that true tubercle bacilli can resist the juices of the stomach and intestines and pass through the digestive tract with their virulence unimpaired.

Heredity.—The older writers looked upon heredity as one of the principal modes of transmission. The fact is now well established that it is rare that animals are born with tuberculosis. While it is true that the disease appears in a very high percentage of the offspring of tubercular parents, this is explained by the fact that such animals are exposed to infection from the date of birth. The very extensive and successful Danish work is based largely upon the knowledge that calves from tubercular cows are born healthy and will remain healthy if they are not exposed after birth to tubercular animals or their products. By keeping these calves apart from diseased cattle and by feeding them milk that has been heated to a point that will insure the destruction of the tubercle bacillus, it is possible to make healthy cows of them. This work is described in detail on p. 247, and it will be seen that it is sufficiently extensive to prove that it is a great exception for an animal to be born with tuberculosis even when its parents are diseased in a high degree.

Another heredity factor that has been thought to be of considerable importance in the development of tuberculosis is the inheritance of a predisposition to the disease; that is, the inheritance of a peculiar weakness of constitution or tissue that serves to render the animal especially liable to the attacks of tubercle bacillus, by making its tissues and fluids especially favorable to their growth. The part played by hereditary pre-disposition is one that has received a good deal of consideration and has been the subject of much discussion. It has been held by some that the factor is a very marked and important one, whereas others maintain that the offspring of tubercular animals not only are not especially predisposed to tuberculosis, but that they possess greater resistance to the action of tubercle bacilli than young from healthy parents. In support of the latter view it has been pointed out that calves from tubercular cows, even when associating with them freely and partaking of the milk produced by them, in some cases require several months to become infected and this in spite of the fact that experiments show that young animals are generally more susceptible to tuberculosis than mature animals.

While no definite statements can be made in reference to actual resistance to tubercle baccilli, it seems natural to believe, and has

always been assumed, that calves from unhealthy parents cannot be so healthy as those from strong, vigorous ancestry and it is known that constitutional weakness predisposes to disease of many kinds. Hence, it has been taken for granted that the offspring of tubercular parents are especially likely to contract tuberculosis when they are exposed to it. It has not been possible to collect scientific data bearing upon this point. The observations that are recorded are open to many objections. Where it is shown, for instance, that a large proportion of the calves of tubercular cows have become tubercular, they have usually been kept under conditions that would lead to the development of the disease whether the calves were predisposed or not. The fact that Professor Bang has been able to establish many healthy herds made up largely of the offspring of tubercular cows, would seem to lessen the force of the arguments for the inheritance of a predisposition to tuberculosis and, especially, since these arguments are based upon inference rather than experience or scientific observation.

Predisposition.—It is well known that some genera of domestic animals are far more predisposed to tuberculosis than others. Exposed equally by feeding infectious material, the pig contracts tuberculosis more readily than the dog. If exposed to infection in the same way, the cow extracts tuberculosis far more readily than the horse. To a less extent there is a predisposition or, on the contrary, a resistance among the individuals of a species. For example, when all of the cattle in a herd are subjected to the same influences and are exposed to tuberculosis in the same way, only a part of them will contract the disease and even after the herd has become extensively infected and nearly all of its members are tubercular, to a greater or less extent, there are usually a few that continue to resist the attacks of tubercle bacilli. Such observations have been made so frequently that it is unnecessary to cite cases or to quote authorities.

Where a number of animals are exposed equally, a difference in predisposition stands out clearly. The causes of this individual predisposition or of this resistance, as the case may be, are supposed to coincide with the factors that combine to lessen or to increase the general vigor, stamina or health of the animal. If the loss of stamina is congenital—that is, if the animal is born with a weak constitution, it may be said to inherit a general predisposition to disease and to tuberculosis. But, beyond this, there is reason to believe that some animals have a specific resistance to tuberculosis that is due to some factor not yet understood.

Stabling.—Among the chief influences governing the spread of tuberculosis in a herd, are stable construction and stable management. It has been stated that cattle on the open plains do not readily contract tuberculosis even when exposed to animals that have it. Nu-

merous observations show that this is so, and the fact that tuberculosis is so rare among western cattle killed for beef is conclusive proof of the same assertion. The freedom of western cattle from tuberculosis cannot be ascribed to the fact that they are not exposed, because the range cattle have been improved by crosses with animals from localities where this disease prevails. It must be that this manner of life has a distinct repressive influence on the progress of tuberculosis in a herd or in an individual. However, open air life and exercise are not always sufficient to prevent the spread of tuberculosis, as is shown by a number of observations.

Professor Stalker, of the Iowa Agricultural College, has found an extensive outbreak of tuberculosis in a herd of beef bred cattle that had never been stabled. Tuberculosis is spreading among unstabled cattle in the Argentine Republic. A Portugese veterinarian has reported the existence of tuberculosis among the wild cattle raised for bull fighting in his country. Moreover, Dr. Fisher, of the Experiment Station of the Kansas Agricultural College, has shown that in a herd of 20 Kansas cows bought up in one of the western counties of that State and selected for their milk-producing qualities and general appearance of health, 10 per cent. were tubercular, as was shown by the tuberculin reaction, and the following post-mortem examinations. Dr. S. W. McClure has also reported an outbreak of tuberculosis among unstabled cattle on a range in Montana, at an altitude of 7,000 feet. Hence, protection by open air life and exercise is relative rather than absolute.

At the other extreme of systems of herd management is the one under which cattle are confined closely for half the year and are kept in small pastures the rest of the year with two daily visits to the stable for feeding and milking. Here we find the other extreme of prevalence of tuberculosis. It it usually in herds managed in this way that the disease makes such great progress as is indicated on p. 21.

Since tuberculosis is very prevalent among some herds closely housed, some of the older writers have been led to assert that it is produced by confinement combined, perhaps, with some other conditions of intensive herd management. This view is sufficiently disproved by the fact that a herd of cows originally healthy may be ever so closely stabled and fed, and cared for in the worst possible way and they will not develop tuberculosis unless the germs are introduced by a diseased animal or the products of a diseased animal. This is shown by everyday experience.

There are many herds in Pennsylvania kept in close, dark, dirty stables that have been shown by the tuberculin test to be entirely free from tuberculosis. This is because it has happened that a tubercular animal has never been added to these herds.

Any system of stable management that serves to bring diseased and healthy animals into intimate contact, that facilitates the deposit of tubercle bacilli within the reach of healthy cattle, that serves to favor the accumulation or the distribution of germs of tuberculosis or to prolong their life in the stable, helps to cause infection. And, further, any system of herd management that tends to reduce the vital resistance of the animal by overwork or improper nourishment, or to depress the activity of the organs or functions by insufficient use, will favor the spread of tuberculosis by preparing the soil upon which the seed is sown.

Stable infection.—It is in the various ways enumerated that the germs of tuberculosis are liberated from a tubercular subject and become free in a stable. The conditions to which they are then subjected have a very great influence on their duration of life and their distribution to other animals. It is evident that any influence conducive to the prolonged life of tubercle bacilli in the stable favors the accumulation of these germs in quantity. For example, if a given case is discharging an average of x germs per day and the conditions as to light, cleanliness and ventilation are such as to lead to the destruction or removal of these germs in one week, there can never be more than $7x$ germs of tuberculosis in the stable that are available for the infection of healthy cattle. If, however, the conditions are such as to permit the retention of life and virulence for ten weeks (70) days, the number of germs in the stable at all times will be approximately $70x$.

It has been shown that the liability of infecting an animal with tuberculosis is increased in proportion to the number of germs that are administered to the animal by inhalation, feeding or inoculation. Therefore, since there are approximately ten times as many germs in the dirty stable that is badly lighted and ventilated as in the scrupulously clean stable that is well ventilated and flooded with sunshine, the danger of infection in the former stable is much greater than in the good stable.

Light.—The value of light lies in the facts (1), that it has a decided germicidal action; (2), that it increases the resistance of animals to the attacks of the tubercle bacilli; and (3), that it favors cleanliness.

(1). It has been shown by Migneco, Straus and others that tubercle bacilli are destroyed by light in a time that is in proportion to the intensity of the light and inversely as the thickness of their protective coating. In Migneco's experiments, sputum containing many bacilli were spread out on linen or cotton cloth and then exposed to sunlight. Subsequently the cloth was washed in sterile water and the wash water was injected into the peritoneal cavities of experimental animals. The virulence of the germs was greatly reduced in

from ten to fifteen hours and when the layer was not too thick, they were completely destroyed in 24 to 30 hours.

(2) Effect of light on the resistance of animals.—Sunlight has a decided effect on the chemical processes that take place in living tissues. In the case of plants this is very marked. Everyone has noticed how plants that grow in dark places are pale or yellow hued, and this is because they lack chlorophyl that can be developed only in sunlight. In the higher animals the effect of light on the chemical processes is almost as well marked. Dammann states that animals expire smaller quantities of carbon dioxide at night than during the day and that the same effect is noticed when animals are maintained in a dark place during the day. According to the experiments of Platin, that were made on rabbits, the increase in oxygen consumption and in carbon dioxide excretion under the influence of light is from 13 to 14 per cent. Dammann calls attention to the fact that this result is in full accord with the general experience that animals fatten best in dark stables and it is also noticed that animals kept in dark places for long periods become sluggish. The pallor that is characteristic of miners, stokers on ocean vessels and prisoners is also due to the absence of light. In darkness there appears to be a checking of metabolism and tissue change, an indolence of excretory functions.

De Renzi has made some experiments to determine the effect of direct sunlight on tubercular processes. He inoculated eight guinea pigs with tuberculous sputum and afterwards placed half of them in a glass box and the others in a wooden box. Both boxes were ventilated from below and were placed in the sun. The animals in the wooden box died on an average of 27 days after the inoculation, while those in the glass box lived an average of 57 days. The experiment was subsequently repeated during the hot season with the result that the animals in the glass box died sooner than those in the wooden box, but the author ascribes this result to the excessive heat of the sun.

Similar experiments have been made in the laboratory of the State Live Stock Sanitary Board, and it has been shown that light prolongs the life of a tubercular animal.

If these experiments do not prove, they at least indicate that the retention of animals in dark stables has the effect of lessening their resistance to tuberculosis.

(3). As to the advantage of light in the stable, it is scarcely necessary to say anything. It is a common matter of observation that dark stables are usually dirty and clean stables are usually light. Light in a stable exposes dirt and enforces attention. The hygienic value of cleanliness will be discussed later.

Ventilation.—An ample supply of fresh air is desirable for three reasons: (1), it has a distinct inhibitory action on the growth of tubercle bacilli; (2), it increases the resisting powers of the animals, and, (3), it dilutes atmospheric impurities and carries them away.

(1). Ransome and Delepine have shown that tubercle bacilli in pure cultures and tuberculous sputum lose their virulence in a few days when exposed to a current of air in daylight and, even in the dark, fresh air has been shown to have a certain mild disinfectant action. By excluding air or keeping the bacteria in a closed space they are found to retain their virulence for a long time. Tubercle bacilli grow best in cultures when the tube is sealed and air excluded.

Where ventilation is bad, whatever impurities enter the air are in a comparatively concentrated form and are proportionately more dangerous than when diluted by a plentiful supply of fresh air that is admitted under a good system of ventilation.

The germs of tuberculosis get into the air either by being discharged into it directly in fine drops in the expired air of a tubercular animal, as has been shown by Flüge and Ransome, or as a result of the drying and pulverization of solid material containing tubercle bacilli such as sputum, material coughed up from the lungs, manure, urine, pus or milk. The danger from this pulverized material has been made clear by the researches of Cornet. When air is vitiated in any of these ways it is dangerous in proportion to the number of tubercle bacilli it contains. Hence the danger of infection is greatly lessened by good ventilation.

It is shown clearly by the statistics of Dr. Ogle and by those of Dr. S. W. Abbott that consumption is far more common among people living and working in vitiated air than among those living in pure air, and similar observations have been made by many veterinarians in reference to cattle.

(2). As to the second advantage of good ventilation, we have the increased vigor and resistance of the animal that is produced by an ample supply of pure air.

A cow weighing one thousand pounds excretes about 800 gallons of carbonic acid gas in 24 hours. According to the estimates of Dammann, if a cow were kept in a room with a capacity of 1,200 cubic feet and the air in this room contained the average proportion of carbon dioxide, which is .4 per thousand, and the room were without ventilation for twelve hours it would contain 3.5 per thousand, and in 24 hours 7.5 per cent. But the animal would have smothered long before this percentage could be reached.

In addition to the contamination of stable air from the carbon dioxide from respiration, a great deal of water is discharged into it in the breath, from the surface of the body and from the excreta. Moreover, the gases that emanate from the urine and manure, espe-

cially if these are retained in the stable for hours and allowed to ferment, or if the floor is not water tight and is loaded with this material, accumulate in large quantities and are decided deleterious. Considerable ammonia also enters the air from the same source. If silage, brewers' grains or other damp or warm food is used, the air is further contaminated from these substances. The combined effect of these contaminating influences has been summed up by Dammann, who asserts that they produce laxity of the skin, weakness of digestion, poor nutrition, imperfect blood-building and reduced resistance to disease-producing influences so that the body is prepared for the reception of other injuries. These results develop slowly, insidiously, but surely.

(3) In addition to the deleterious gases that are removed by ventilation, a sufficient exchange of stable air, without strong draughts, helps to keep down the dust contained in the air. Dust in the air is injurious because it irritates the mucous membranes of the respiratory tract and causes catarrhs of the nose, throat or bronchial tubes, thus preparing the tissues for the attack of the tubercle bacilli and, further, tubercle bacilli in the air usually exist as dust particles and are carried independently or attached to other larger particles, so that by keeping down the visible dust we are also repressing the invisible particles that are even more injurious. Without ventilation, these particles accumulate and concentrate. With judicious ventilation, they are carried away; but extreme currents of air are objectionable not only for the reason that they chill animals unduly, but they also tend to dislodge particles that are attached to the stable surfaces and carry them into the air from places where they are doing no harm. The action of currents of air in dislodging bacteria on both dry and moist surfaces has been studied in detail by Flüge.

Cleanliness.—The hygienic value of cleanliness can scarcely be over estimated. Practical sanitary science is made up largely of cleanliness. If cleanliness is not next to godliness it is at least next to wholesomeness.

By keeping a stable clean, a very large proportion of all the tubercle bacilli excreted is removed from the reach of the stable occupants and thus has no opportunity to cause infection. It has been shown by Koch, Cornet and others that expectorations out of direct reach do no harm until they are dried and pulverized, thus enabling the germs they contain to enter the atmosphere. This is because such material is sticky and is attached to one spot until desiccated, unless atomized by a strong current of air. After it is thus distributed, the chances for it to reach and infect an animal are immeasurably increased. The same principle applies to tuberculous material excreted in the urine or manure. Animals are not as a rule

exposed to direct infection from large accumulations of dung, but to the smaller quantities that dry in the passageways, on the stall-partitions or on the wall and are afterwards ground up into powder and distributed by the air. When thus distributed they may be inhaled or they may contaminate the food and be swallowed with it. The thick scales of food, expectorations and saliva that are found plastered on the mangers, feed boxes and stall partitions in dirty stables are dangerous.

Experiments made in the laboratory of the State Live Stock Sanitary Board have shown that where the stable was occupied by tubercular cattle, such material may be infectious. Accumulations in the manger, feed box, etc., are more dangerous than the dust that has floated to the upper parts of the stable.

Attention has already been called to the fact that the danger of infection is increased to the animal in proportion to the number of germs to which it is exposed. In well kept stables the visible accumulations of dirt and filth are removed and with this material a large proportion of the tubercle bacilli is taken away from the reach of the members of the herd and the chances for infection are reduced.

Stall constructions that are of a complicated character, cumbersome feed boxes with deep corners out of reach, board partitions with broad cracks, spaces beneath loose floor boards and rotten wood work, are all exceedingly objectionable because they offer so many opportunities for the concealment and accumulation of bacteria-bearing dirt. For the same reason, rough sawn lumber is not so well adapted for interior construction as well planed boards. The simpler and tighter the interior construction the better. The joints and angles should be as few as possible, the surfaces should be smooth, the floor should be so arranged that it have good drainage and that it can be washed readily and the interior of the stable should be kept clean and frequently whitewashed or sprayed.

The necessity for removing dirt and substances that may contain tubercle bacilli is emphasized by our knowledge of the resistance of these germs when contained in such material. Eichborn has studied the resistance of tubercle bacilli when subjected to various influences and contained in mixtures of earth, manure, manure water, vegetable matter, as potatoes, etc. Tuberculous sputum mixed with earth and kept for 3½ months at a temperature ranging between freezing and 78 degrees F. was still virulent. Sputum mixed with manure or manure water and kept at similar temperatures for four months had lost none of its virulence.

Dampness.—The influence of dampness in stables deserves much consideration. It is a matter of common knowledge that damp houses are unwholesome and no one would think it possible for

people to remain well while living in damp cellars; but this point has been seriously overlooked in stable construction and in herd management. Many stables in Pennsylvania are built with stone walls against embankments of earth. Such walls are always damp from the entrance of water by capillary attraction. They are sometimes so damp that drops accumulate on the inner surface and run down in streams. In other cases, the water that comes in is not plentiful enough to accumulate in visible drops and is carried into the air by evaporation as rapidly as it passes through, making the wall cold. The floors in many stables are also damp. They are without drainage, or without sufficient drainage, and are sometimes damp not only from the voidings of the animals in the stable, but also from the penetration of ground water from the side of the stable or from below. Under these conditions the constant evaporation of water and the saturation of the atmosphere with its vapor produces a low temperature that the herdsman tries to overcome by closing the stable tightly to prevent the egress of the air the cattle have warmed. When this is done, the great quantity of vapor that is exhaled from the lungs of the animals accumulates in the air to the saturation point and the water is then deposited on the ceiling, on the walls and even on the cattle themselves. If fresh, cold air is then admitted to the stable, or if the cattle are turned out, the animals experience great discomfort, as is shown by the roughening of the coat, the contracted posture and trembling. The prolonged action of such a condition is very deleterious. It produces catarrhs and lowered vitality.

Dr. Parker has called attention to excessive moisture in and about the stable as one of the predisposing causes of tuberculosis. It appears to be one of the important influences affecting the spread of tuberculosis in a herd.

Stall Construction.—The plan of the stable, and especially the stall arrangement has a most important bearing on the distribution of tuberculosis among the members of a herd. My attention was first called to this point when in 1892 I tested two herds with tuberculin. One of these was housed in a well ventilated but indifferently lighted stable where the cows were kept in box stalls with solid partitions about 4 feet high. One of the animals in the herd reacted to the test, was condemned as tubercular and killed. The post-mortem examination showed the disease to be extensively distributed in the body of the animal. This cow had been in the herd for several years, but none of the other animals was affected, and although the herd has been under observation ever since and has been tested three times, no indication of tuberculosis has appeared in any other animal. In the other herd, the cattle were confined in stanchions

arranged in rows across the stable and the stable was fairy well ventilated, light and clean; but more than half the cattle were found to be afflicted with tuberculosis. In this case, there were no partitions between the animals and no mangers. The cows could reach their neighbor's food, could lick each other and cough in each other's faces.

In another herd, kept in a similar manner, in which the infected animal had been brought in at a more recent date and had died of tuberculosis soon after its introduction, it was found, upon testing the herd, that the cow on each side of the stall occupied by the original tubercular cow responded to the test and was tubercular, while the rest of the herd was entirely healthy. A very instructive observation in this connection was made by Dr. Jno. W. Adams during the summer of 1898 in testing a herd of 142 cattle, of which 52 were found to be tubercular. The stalls were broad and made to accommodate two cows. They were closed in front and the partitions were solid and as high as the cow's back. It was found upon testing the herd that in very many cases the animals responded in pairs; that is, both the occupants of a stall were tubercular when the cows in adjoining stalls were healthy. In the few exceptions to this rule, in which one of the cows in a stall was tubercular and the other healthy, a study of the herd records showed that the tubercular cow had been with its associate only a short time and was previously stalled with another tubercular cow. It was very clear in these cases that where a tubercular cow was paired with a healthy cow she had in most cases infected her mate. The distribution of the animals throughout the stable in pairs that were healthy and pairs that were diseased was most impressive and instructive. Dr. Jobson has recently observed the same condition in two other herds stalled in this way.

Friedberger and Fröhner call attention to the fact that the observation has been made in Germany that when a tubercular cow is placed in a stable, the disease often progresses along a row, passing from one to another in regular order, with few omissions.

In cases in which only one or a few tubercular cattle are found in a large herd and have been in the herd for a considerable period. it is the rule to find that such animals have always occupied the same stalls and that there is a more or less complete separation between the individuals of the herd.

Numerous observations of a similar character might be cited, but these are enough to call attention to the fact that the spread of tuberculosis in a herd depends, in large measure, upon the intimacy of contact between cattle while in the stable, and to impress the statement made above that the method of stall construction has much to do with

the spread of this disease. Each cow should have the exclusive use of a certain stall.

The more perfect the isolation, the fewer the chances for transmission from animal to animal and, therefore, the slower the spread. As giving the greatest degree of protection, box stalls are undoubtedly best, but box stalls are rarely feasible in practical dairy herds, and the method of construction that is next best is that in which there are stall partitions as high as the cows' backs and extending forward far enough to keep their muzzles apart. Thus there is also separation of feed boxes.

The use of a common watering trough appears to be dangerous under some conditions. If the trough is protected from the sun and contains still water, it may become infected by a tubercular cow and endanger healthy animals drinking from it. If, on the other hand, the trough is exposed to the sun and is filled with running water removed from the surface there is comparatively little danger. The best method of watering cattle, in so far as protection from tuberculosis is concerned, is the individual cup system wherein there is a cast iron cup in each stall in which the water is kept at a certain level by means of an automatic attachment. In some new stables cows are fed and watered from a common trough that extends in front of the stalls the length of the row. This is usually filled with water from one end, so that before the current reaches the last cow it has washed over the feeding places of all the other cows in the row. There can be no doubt that the danger of carrying infection by this method must be very great and the danger from a single tubercular cow in the row is greatly enhanced by this system.

Exercise.—Exercise is essential to perfect health. It is known to all, that moderate use strengthens any muscle or organ of the body, and disuse leads to atrophy. Continuous stabling without exercise weakens the muscles, the respiratory system and the organs of circulation. Exercise not only strengthens the muscles, but it also increases the demand for oxygen and for blood, this leading to deeper breathing and increased nutrition. During recent years dairymen have been advised repeatedly and in many official publications, not to exercise their cows because it is pointed out that exercise increases the demand for food, that it consumes nutritive material accumulated in the body and is therefore costly. It must be admitted that cows will, as a rule, eat more when exercised moderately than when receiving no exercise, but at the same time every successful dairyman desires to see his cows eat plentifully. In a test of a Jersey cow conducted for the purpose of establishing a record for quantity of milk produced in a year, it was found necessary to force the cow to exercise so that her appetite would continue

large that she might be able to continue her enormous yield of milk. In Germany, milch cows are used on many farms for draught purposes, and it is surprising to learn that cows are able to draw a plow or a cart six or eight hours a day and still produce 20 to 30 pounds of milk. Many cows of the Simmenthal breed in South Germany do this.

On one large farm where there were formerly some tubercular cattle, the cows were watered in or near the stable and received but little exercise during the winter. The herd was tested with tuberculin and tuberculosis was cleared out and the system was then adopted of compelling the cows to walk for their water to a hill a distance of nearly half a mile. This system was followed in all kinds of weather and the herd is healthier, the cows larger and better looking and more productive now than ever before.

Keeping animals in the stable continuously, leading, as it does, to shallow breathing and imperfect development of the lungs and heart, greatly lessens the vitality and resistance of the animal to unfavorable influences. This result may be intensified by breeding and if several generations of animals are kept in this way, the offspring must be delicate and of weak constitution.

In breeding race horses the best results are obtained by mating developed stallions and developed mares. The strength and power that are developed by use and training are thus transmitted with greater certainty to the offspring. Who would expect to obtain race horses by breeding from stallions and mares undeveloped for generations? And who can expect to obtain calves with well developed lungs and hearts and vigorous constitutions from bulls and cows that do not possess these essential requirements and do not come from immediate ancestors possessing them?

Of course, the importance of exercise is not so great in non-breeding herds as it is in herds kept for the production of calves as well as milk. While the importance of this factor in the breeding herd cannot be over-estimated, still exercise must be kept within reasonable bounds. A cow should not be required to do hard physical work, produce milk and carry a calf at the same time, notwithstanding the German practice.

That a cow can produce a large flow of milk and do lots of walking besides is shown by everyday experience when cows are at pasture. *Cows should have an opportunity to exercise in the open air every suitable day and it is well to have a barnyard so sheltered that it will be possible for the herd to go out comfortably in all kinds of weather.*

INFLUENCES AFFECTING THE PROGRESS OF TUBERCULOSIS IN AN INFECTED ANIMAL.

There are a number of influences that operate especially to influence the progress of tuberculosis in an animal, and of these a few deserve special mention.

It is hardly possible to consider the spread of tuberculosis in a herd apart from the influences that govern the progress of the disease in the individual. Many of the influences that are discussed above in relation to the spread of disease among members of the herd, operate wholly or in part by reducing the ability of the animal to resist the attacks of the germs, thus favoring the dissemination of disease. These influences operate on the individual and if they continue after infection takes place, that is after the seed is planted, after the tubercle germs have passed into the tissues of the animal and have commenced to grow and produce abnormal conditions, they will materially influence the progress of the disease in the animal. Then, by favoring rapid development of disease in the individual, these influences will favor distribution of tuberculosis in the herd, because an animal in an advanced stage of tuberculosis has a large area of morbid tissue and much noxious material in the body, the fragments of which are constantly being expelled. An advanced case of tuberculosis is a more active distributor of germs than a less advanced case and the more the germs, the greater the danger.

Tuberculosis is essentially a chronic disease; its general tendency is to progress slowly; sometimes it becomes latent and makes no progress for a long time. Sometimes the resistance of the animal is so great that even after distinct tubercles have formed in the tissues, they are surrounded and walled in by fibrous tissue until all of the germs of tuberculosis in this enclosed area have died. Then the fibrous wall contracts until in time there is nothing left but a scar to mark the battlefield where the enemy was vanquished.

In cattle, this result is excessively rare and by no means as common as it is in man. If a man is told by his physician that he is "threatened with consumption," he is at the same time advised to work less, rest more, to eat more nourishing food and if he can afford it, to go to North Carolina or Colorado or to some other high and salubrious locality and live in the open air. In other words, the conditions of life are changed and are made more favorable. After a cow contracts tuberculosis she is continued under precisely the same conditions. She receives the same food, she is expected to produce as many calves and as much milk as before, her stable is not altered or improved and her general conditions of life remain unchanged. Therefore, the conditions that made it possible for the germs of tuberculosis to become established in her system, enable them to continue

to flourish and the cow becomes a more or less rapid victim to tuberculosis; the length of the period of disease depending upon her original vitality and upon the conditions to which she is subjected. If the conditions are good, the disease may make slow progress, requiring months or years for its full development. If, on the other hand, the conditions are bad, or if especially unfavorable influences are interposed, the disease will progress rapidly and it may produce an acute form of tuberculosis that will kill the animal within two weeks after it shows the first physical signs of disease.

The important influences that tend to retard the progress of tuberculosis and the absence, lack or opposite of which tend to facilitate its progress, are the following:

Constitution.—Cattle with the strongest and most powerful constitutions will contract tuberculosis if exposed to a sufficient number of tubercle bacilli. As a rule, a longer exposure is required (more germs), to infect such cattle than to infect those of a weaker constitution. After infection occurs, that is, after disease is started, the emaciated or debilitated animal, or the animal that has been depleted by excessive use of any kind—milk, work or breeding—will offer little resistance to the invasion of its tissues by the germs of tuberculosis through its tissues and will soon pass into an advanced stage of disease.

Age.—An animal in the prime of life and vigor is better able to resist the progress of tuberculosis than one that is partly mature or one that is advanced in years.

Use.—The use to which an animal is put has much influence on its resistance to disease. An animal that accomplishes an extreme amount of work is often depleted thereby, hence, cows that are heavy milkers seem to be somewhat more predisposed to tuberculosis than cows that are less productive. Reproduction is also an important influence. It is noticed frequently that cows with a latent or comparatively chronic form of tuberculosis, succumb to an acute exacerbation of the disease immediately following calving. The cow was strong enough to resist the rapid advance of disease so long as she was in a normal and undisturbed condition, but when the calf was born she was temporarily depressed and depleted and the waiting germs are quick to advance when resistance is lessened.

Bulls depleted by service in a large herd, are less resistant to tuberculosis than those of which less service is required.

But no breed of cattle and no class of cattle is exempt from tuberculosis. It occurs occasionally among oxen and steers, and that the milking breeds do not have a monopoly of the disease is shown by the fact that some of the best Herford and Aberdeen-Angus herds in Great Britain have been sadly injured by tuberculosis.

Feeding.—Tuberculosis makes very much slower progress among cattle that are well fed than among those whose nutritive wants are scantily supplied.

The State Live Stock Sanitary Board had in its experimental herd three cows with tuberculosis that were taken from badly infected herds and were looked upon as fairly advanced cases. After these cows came into the custody of the Board they were well fed, and the ration was a broad one, about 1 to 7, with the result that all improved greatly in condition and none of them for a period of almost a year would have been picked out by an experienced stockman as a tubercular animal. But these cows were not cured and after this temporary improvement, they again lost condition and in time developed the usual clinical signs of tuberculosis.

The use of fatty and carbonaceous foods, such as cod-liver oil, cream, etc., are recommended by physicians to their consumptive patients. In the same way it appears that a fattening ration has a certain tendency to retard the progress of tuberculosis in a cow, although I am not prepared, until more observations have been made, to say that this is the rule. It is certain that cattle well fed will resist tuberculosis longer than cattle sparsely fed.

Light and ventilation.—The value of light and ventilation both in respect to checking the progress of disease in a herd and in an individual, have been referred to in a previous section of this chapter. It has been shown by definite experiment that light undoubtedly enables the animal to resist the attacks of the germs of tuberculosis for an increased period. Since it is well known that vitiated air greatly depresses an animal and its vital functions, thus lowering its vitality and injuring its constitution, it is clear that the absence of adequate ventilation will tend to lower the ability of the animal to resist tuberculosis. *The open air treatment for tuberculosis is more beneficial than any other.*

Exercise.—The importance of exercise has already been mentioned and the benefit conferred by it upon the individual has been pointed out. An animal with lungs that can be fully expanded, with a heart that is vigorous and strong and is pumping a full supply of blood to all parts of the body can be depended upon to resist tuberculosis for a longer period than an animal with partly collapsed lungs, with a weak heart and indolent circulation. The first conditions are favored by exercise, the latter result from lack of exercise and long continued confinement.

Other diseases.—Other diseases that deplete an animal during the course of the tubercular infection favor the progress of tuberculosis. This has been noticed where animals are exposed to and contract other acute infectious diseases. Bang calls attention to

the rapidity with which tuberculosis spreads in a herd after an outbreak of cowpox or foot and mouth disease. An exacerbation of the symptoms of tuberculosis may often be seen after an attack of garget, pneumonia or even severe indigestion. The explanation in all these cases is that tuberculosis is there at the onset of the other disease and the depletion produced by the other disease weakens the resistance of the animal to the germs of tuberculosis so that they are permitted to spread with rapidity.

THE EXTENT TO WHICH TUBERCULOSIS MAY BE CHECKED BY GOOD CONDITIONS OF LIFE AND CARE.

It should be observed that in discussing the conditions bearing upon the spread of tuberculosis in a herd and in an individual I have not called attention to the conditions under which tuberculosis may be cured and for the reason that it is impossible to prove full recovery from tuberculosis during life and it is so rare among cattle under any conditions as to be at present of little practical importance. On the other hand, there are many conditions and many combinations of conditions that are favorable to latency of disease, and tuberculosis may, under favorable conditions, be kept from making progress for years or until the animal is disposed of for beef or dies of another disease or of old age.

Under some practical conditions, such latency confers as much economic advantage as actual cure because the productivity of the animal is scarcely diminished and at the end of its period of useful life it is converted into food for man; this can sometimes be done with safety if well known precautions as to competent meat inspection are observed.

There is a vast difference, however, between such latency and cure. An animal that is cured of tuberculosis is no more dangerous than an animal that has never had the disease and is quite as safe and useful for all purposes, but an animal with latent tuberculosis possesses potentialities for spreading this scourge to other animals and to human beings, the magnitude of which cannot, in each individual case, be accurately gauged. An animal with latent tuberculosis and harmless to-day, may, within a week, become a prolific distributor of deadly germs; an animal with latent tuberculosis has within its body a resting seed-bed of disease that is ready to sprout and spread the moment the conditions become favorable.

It must be remembered that tuberculosis begins in all cases as a single, exceedingly minute area of disease. If the disease could be checked at this stage it would be well and good, but the fatal cases, and the cases in which enormous accumulations of consumptive

pus and diseased tissue debris collect in the chest or in the abdomen or form in the udder, commence in just such small, apparently insignificant tubercles. For this reason it is absurd to say that because a certain case is, as the moment, in the early stages and shows but slight lesions, it is not destined to become dangerous and harmful, unless one wishes to deny all of the established facts as to the dangers of tuberculosis of cattle.

Nor is the fact that an animal has tuberculosis in a restricted area an evidence that it will necessarily be incapacitated by disease within a short time. Reference has been made above to the prolonged periods of latence that characterize some cases of tuberculosis in strong individuals, kept well and under good conditions. In the Danish work it has been found that some reacting cows may be kept in good condition for as long as four years and perhaps longer. Indeed, it is not impossible, under some circumstances, for a tubercular cow, as for a consumptive man, to live a long and productive life and die of some disease in which tuberculosis has no part.

It should be observed, however, that if tubercular cattle are maintained alive it should only be under special precautions, for every tubercular animal is a possible source and most tubercular animals are at some time actual sources of infection and danger.

Tuberculosis can not be eradicated from a herd as long as tubucular animals are permitted to associate with herd-mates that are healthy. Under such conditions, new cases constantly arise and the disease is perpetuated.

CHAPTER III.

THE RELATION OF BOVINE TUBERCULOSIS TO PUBLIC HEALTH.

SUMMARY.

IN 1865, VILLEMIN SHOWED FOR THE FIRST TIME THAT TUBERCULOSIS WAS A COMMUNICABLE DISEASE, AND THAT THE FORM SEEN IN CATTLE WAS ESSENTIALLY THE SAME AS THAT IN MAN. SOON AFTER, CHAUVEAU PROVED THAT IT COULD BE TRANSMITTED BY THE ALIMENTARY TRACT, AND WARNED AGAINST THE USE OF FOOD CONTAINING TUBERCULOUS MATERIAL. THE TRANSMISSION FROM MAN TO MAN AND FROM ANIMAL TO ANIMAL IS NO LONGER QUESTIONED BY ANY ONE. THE PROOF OF THE TRANSMISSION FROM CATTLE TO MAN THROUGH FOOD IS NOT EXPERIMENTAL, AS IT IS MANIFESTLY IMPOSSIBLE TO TRY DIRECT EXPERIMENTS ON MAN; BUT THERE ARE ON RECORD A LARGE NUMBER OF OBSERVATIONS SHOWING INFECTION IN THIS WAY WHICH ARE ALMOST AS CONVINCING AS EXPERIMENTS, SUCH AS THOSE OF STANG, DEMME, OLLIVIER, GOSSE.

MILK FROM TUBERCULAR COWS CONTAINS THE TUBERCLE BACILLUS, AND READILY PRODUCES THE DISEASE IN CALVES, PIGS, RABBITS AND OTHER ANIMALS WHICH ARE FED ON IT. THE BACILLI OFTEN PASS INTO THE MILK OF COWS WHICH SHOW NO EVIDENCE OF UDDER TUBERCULOSIS AND IN WHICH THE DISEASE CAN BE DETECTED ONLY BY THE USE OF TUBERCULIN. ALL THE PRODUCTS OF MILK ALSO MAY CONTAIN THE BACILLI. THEY CAN LIVE 120 DAYS IN BUTTER AND 11 MONTHS IN CHEESE. THEY ARE NOT KILLED BY THE GASTRIC JUICE DURING DIGESTION. THE TONSILS NOT UNFREQUENTLY BECOME AFFECTED.

MEAT IS DANGEROUS WHEN SOILED BY MATERIAL FROM SOFTENED GLANDS OR ORGANS, AND WHEN THE DISEASE IS WIDELY GENERALIZED, ESPECIALLY IF THE INTER-MUSCULAR GLANDS ARE INVOLVED. THE BLOOD CONTAINS THE GERMS OF TUBERCULOSIS WHEN THEY ARE DISCHARGED INTO IT FROM A LOCAL LESION.

THAT MILK FROM DISEASED COWS CAUSES TUBERCULOSIS IS INDICATED BY THE LARGE PERCENTAGE OF CHILDREN WHO HAVE TUBERCULOSIS OF THE INTESTINE, AND BY THE FACT THAT WHILE THE DISEASE IS DECREASING IN ADULTS, IT IS INCREASING IN CHILDREN AT THE AGE WHEN MILK IS MOST LARGELY USED AS FOOD.

THE JEWS WHO ARE VERY CAREFUL ABOUT THE MEAT THEY EAT SHOW A REMARKABLE FREEDOM FROM TUBERCULOSIS.

CASES OF DIRECT INOCULATION OCCUR FROM CATTLE TO MAN THROUGH WOUNDS ACCIDENTALLY INFLICTED, AND SOMETIMES

PROVE FATAL, SHOWING THAT THE GERM AS FOUND IN CATTLE CAN THRIVE IN THE BODY OF MAN ALSO.

THE FORMER BELIEF THAT TUBERCULOSIS IS AN INHERITED DISEASE IS ERRONEOUS. THE INFLUENCE OF HEREDITY IS SO SLIGHT THAT IT MAY PRACTICALLY BE DISREGARDED IN CONSIDERING MEASURES LOOKING TO THE PREVENTION OF THE DISEASE.

REVIEW OF THE DEVELOPMENT OF KNOWLEDGE OF THIS SUBJECT.

The discovery of Villemin, communicated in 1865, that tuberculosis was a contagious and virulent disease, and his later experiments showing that tuberculosis as seen in cows is identical with that seen in man, opened up a new field of investigation to the scientific medical world. In the storm of opposition which his views aroused, Chauveau took up the question in a new way, namely, inoculation or infection by means of the digestive tract. His success was absolute from his first experiment, and at once, with farseeing acumen, Chauveau insisted upon the necessity of taking precautions in regard to food supplies coming from tuberculous sources. From all parts of the world material has been constantly pouring in, so that to-day there is no one who has made a study of the question who does not accept it as an axiom, that tuberculosis is contagious for man and for animals. The identity of the disease as seen in man and in the lower animals is no longer questioned by anyone. If proof had been needed further than that given by Villemin and Chauveau and by the experimenters following them, the discovery of the bacillus of tuberculosis by Robert Koch in 1882 would have settled the matter.

Villemin's work.—It will be interesting to review to a certain extent the work of different experimenters, beginning with Villemin, so that we may judge for ourselves the justness of the conclusions stated above. In almost every age we see, here and there, a man, who by his attainments and by his foresight, towers above his surrounding brethren. Such was indeed Villemin. At the time when he first undertook his work on tuberculosis, spontaneous generation was believed in by many scientific men, and even physicians of repute believed in the spontaneous generation of lice, of worms, of itch and of ring-worm, their belief being based upon cases in which contagion could not be clearly made out. It must be remembered that Pasteur's work, showing the impossibility of spontaneous generation, had not been completed, and that even ten years after Villemin had done his work, and expressed himself so emphatically (as will be shown below), on the subject of the contagious character of tuberculosis, at a meeting of the Pathological Society of London, held on the sixth of April, 1875, to discuss the question of the "Germ Theory of Dis-

ease," Dr. Bastian, who was the leader of the debate, took the ground that "the grouping of the ultimate particles of matter to form living organisms was an operation as little requiring the action of antecedent life as their grouping to form any of the less complex chemical compounds." This attitude of the medical world makes the work and the conclusions of Villemin excite our admiration in a still greater degree, especially when it is remembered that many of the conclusions arrived at by Villemin, even in the light of the thirty-five years of constant work by able men all over the world, need no change and no correction. On the fifth of December, 1865, Villemin made his first communication on the subject of the inoculability of tuberculosis to the French Academy of Medicine, detailing in his note the experiments on which he based his conclusions. He says, "Tuberculosis is the effect of a specific, casual agent; of a virus. This morbid agent ought to be found, like its congeners, in the morbid products which it has determined by its direct action on the normal elements of the affected tissues, introduced in an organism capable of being affected by it. This agent ought then to reproduce itself, and to reproduce at the same time the disease of which it is the essential principle and the determining cause." Further, he says: "Tuberculosis is a specific affection. Its cause resides in an inoculable agent. Tuberculosis belongs then to the class of virulent maladies, and ought to be placed in our nosological tables alongside of syphilis, but more nearly to glanders and farcy." Later, when discussion arose as to the nature of grape disease in cattle, known in France as pommeliere, and its relation to the tuberculosis of man, Villemin took the ground that inoculation was the only true test. He says, "we have here a difficult point of controversy to resolve by ordinary means, but by inoculation the solution is rendered easy." Following the inoculation and reproduction of the disease in rabbits, in the same manner in which he had been able to reproduce the disease as seen in man, Villemin concluded that "calcareous phthisis of cows is identical in nature with tuberculosis in man." Apart from the conclusions derived from experimental sources, Villemin gave sound and true arguments to support his position. He showed that the distribution of tuberculosis was in close relation to the density of the population; that the frequency of the disease was due to the thickness of settlements; that it is found principally in capitals and in cities containing manufactories, and where commerce is extensively carried on; that in country regions it is more rare. He showed that close confinement, sedentary life, and close crowding exercise an influence of the same kind. To these reasons the extreme frequency of phthisis in prisons, factories, convents and barracks is due. Soldiers in barracks in time of peace furnish a larger portion of phthisis than troops on a campaign, camping

in tents and bearing all the fatigues and misery of war. Tuberculosis spares isolated individuals, or those living in the open air. It is almost unknown among the inhabitants of the Grand Steppes in Russia, the Kerghis. It is very rare among the Arabs who live in tents. In these respects, tuberculosis is like infectious diseases, of which the frequency is increased by the density of population, while they grow less or pass away by the dispersion and isolation of individuals. He showed further that the history of tuberculosis is like that of other contagious diseases. Said he: "Zymotic maladies whose causal agent is a specific virus, have not generally been seen all at once over the entire world. They made their appearance in certain countries, and have only extended to different people on the face of the earth progressively, following intercourse between people affected and those who were still healthy. This has been shown for syphilis, for small-pox, for plague, and for cholera. The existence of tuberculosis goes back to historical times, as far as concerns the old continent, but is it the same for the new world and the Oceanic Islands? It does not seem so. Different documents tend to prove, on the contrary, that certain peoples did not know this scourge, and that they owed it to importation by their conquerors. In North America phthisis seems to have made its appearance among the Indians, only following their communication with Europeans. In Australia, in New Zealand and in the Polynesia Islands the same is true. It is certainly a curious phenomenon to see indigenous races melt away, so to speak, and tend to disappear by the ravages of a scourge which they did not know before the coming of Europeans."

He says, further: "The virus behaves like a parasite. It multiplies itself and by itself. We only furnish the means by which it lives and reproduces itself; we never create it. This affection, like all its congeners, is not a spontaneous creation of the body. Neither debility nor fatigue nor pain nor heat nor cold is able to make it break out in the body. To be born, a germ is necessary; it can come only from the outside. Its inoculability shows that this germ multiplies itself and perpetuates itself in the organic media of man and of certain animals."

Feeding experiments by Chauveau.—The experiments of Villemin and the conclusions he drew from them aroused the greatest interest throughout the scientific world, and in all quarters experimenters took up the work, some with the idea of confirming it and some with the idea of disproving it. Among these two stand conspicuous—Chauveau and Cohnheim. Chauveau, remembering that anthrax and glanders could be produced through the intestinal tract and that he himself had shown that the vaccinia eruption could be produced by ingestion of vaccine matter, was led to take advantage of this important observation in the settlement of the question. This mode of in-

fection was not open to the objections which had been raised against subcutaneous or intravenous inoculation, since it did not necessitate any breaking of the skin or injury of any sort. His experiments were further valuable in that they were carried out on large animals; namely, of the bovine species, for, as he said: "They are the only ones on the face of the earth which partake with the human race the sad privilege of keeping alive tuberculosis." He bought in the neighborhood of Aix-les-Bains four heifers, aged six and twelve months, animals coming from the mountains where phthisis is practically unknown. The three best of these were to be infected and the fourth was kept as a control. He made each of the three swallow about thirty grams (one ounce) of tuberculous matter, obtained from the lungs of an old phthisical cow. The matter was broken up in a mortar, diluted with water, and each of the animals was made to drink it from a bottle introduced into the back of the mouth. At the end of twenty days there was no longer any doubt as to the success of the experiment. The three heifers inoculated grew very thin and feeble, showed staring coat, were dull and coughing. Fifty-three days after the injection the three heifers were profoundly diseased, whilst the control heifer was in perfect condition. The post-mortem examination showed most perfect lesions of generalized tuberculosis with well marked predominance in the mesentery and intestine. "In view of these facts," concluded Chauveau, is it possible to entertain doubts concerning the virulence of tuberculosis? I do not believe it. It appears to me proven now that the identity of character of tuberculosis with diseases known to be virulent, is so complete and so absolute that one must either recognize the virulent character of tuberculosis or else deny virulence itself. The conclusions that Villemin has drawn from his work of inoculation has then the full value which he attributed to it."

The experiments of Chauveau opened a new question, of which he was not slow to see the importance, for he reasoned that in man as well as in animals transmission of the disease is possible by the use of meat or of milk coming from a tubercular animal. Ever since his experiments, he has constantly urged with the greatest perseverance, a perseverance which, as he says, "he has the right to call stubbornness," the importance of taking measures to prevent contagion of man and animals by matter derived from bovine sources, taking the ground that bovine tuberculosis should be classed amongst those diseases which should be under the control of the sanitary police.

Experiments of Cohnheim.—Cohnheim, who at this time (1869), was one of the strongest men in Europe in the study of pathology, undertook with B. Fränkel, at the Pathological Institute of Berlin, a series of experiments which were apparently very decisive against the speci-

fic character of tuberculosis, as a result of which he opposed the views of Villemin, but later, in repeating his experiments at Breslau and with Salomonsen, the results were such that he became the strongest supporter of Villemin's work. In fact, it was due to his able presentation of all the facts in favor of the infectious character of tuberculosis that the last opponents gave away, and in 1879 he clearly foretold the discovery of the tubercle bacillus.

Discovery of the Tubercle Bacillus by Koch.—Three years later, on the 24th of March, 1882, Robert Koch, of Berlin, communicated to the Pathological Society of Berlin the results of his researches into the etiology of tuberculosis, which ended in the discovery of the bacillus of tuberculosis, the specific causal agent of tuberculosis, in whatever form it may manifest itself. Koch's work will always remain classic. Since that time experimenters all over the world have repeated his work and advanced it as far as possible, the result being that at the present day no one doubts the causal relation of the tubercle bacillus to the disease known as tuberculosis in any of its various manifestations in different parts of the body, or in mammals of whatever species.

In evidence of the completeness of Koch's work the following resumé of his investigations may be quoted: "In 19 cases of miliary tuberculosis the bacilli were found in the tubercular nodules in every instance; also in 29 cases of pulmonary phthisis, in the sputum, in fresh cheesy masses, and in the interior of recently formed cavities; in tuberculous ulcers of the tongue, tuberculosis of the uterus, testicles, etc.; in 21 cases of tuberculous (scrofulous) lymphatic glands; in 13 cases of tuberculous joints; in 10 cases of tuberculous bone affections; in 4 cases of lupus; in 17 cases of perlsucht in cattle. His experimental inoculations were made upon 278 guinea pigs, 105 rabbits, 54 field mice, 28 white mice, 19 rats, 13 cats, and upon dogs, pigeons, chickens, etc. Very extensive comparative researches were also made which convinced him that the bacillus which he had been able to demonstrate in tuberculous sputum and tissues by a special mode of staining, was not to be found in the sputa of healthy persons, or of those suffering from non-tubercular pulmonary affections or in organs and tissues involved in morbid processes of a different nature."

This discovery at once set at rest the question of the transmissibility of tuberculosis from one person or animal to another, and also by reason of the varied sources in both man and animals, from which Koch obtained the identical germ, and with it reproduced the disease, proved the identity of the disease as seen in different animals and in different parts of the same animal. Accepting then the identity of the disease as seen in the bovine species and in man, the question already put forward by Klebs and Chauveau as to the danger to

man in the consumption of meat and milk from tubercular cattle assumes at once its rightful importance. Tuberculosis from these sources is naturally by ingestion, and infection takes place in some part of the digestive tract, and as shown by Chauveau, "the lesions caused by ingestion of tuberculous material are characterized by a special localization. The initial and most pronounced lesions first show themselves in the lymphatic glands of the intestine, the solitary glands, and patches of Peyer; the mesenteric glands, then the lymphatic glands of other regions, the spleen and the liver. The lungs are affected more slowly and in a less marked manner." As a rule the lesions beginning from absorption of tuberculous material by the digestive tract will be located in the mesenteric glands, pointing to their mode of origin.

Cases of Tuberculosis caused by food.—While it is necessarily impossible for us to try direct experiments to prove the transmission of tuberculosis from animals to man by means of ingestion, we have obtained the most conclusive proofs of the possibility of this by experiments on animals; and there are not a few cases in man, where the evidence is so complete as to leave no doubt of its origin. A few of these may be quoted: Dr. Stang, of Amorbach, mentions a case of a boy five years of age, well developed and born of healthy parents, whose ancestors on both sides were free from any hereditary taint, who died after a few weeks of acute tuberculosis of the lungs, with enormous enlargement of the mesenteric glands. It was found that this child had taken milk fresh from a cow which had been slaughtered a short time before, and found to be a victim of pulmonary tuberculosis. Four similar observations have been published by Dr. Demme, physician-in-chief to the Children's Hospital in Berne. Four children from healthy parents without tuberculous ancestors, died of intestinal and mesenteric tuberculosis in consequence of having used the raw milk of tubercular cows for some time. In nearly two thousand tuberculous children seen by Demme in twenty years, these four were the only ones in which he could with certainty eliminate any other cause for the disease. This shows the care with which Demme selected these cases, and makes them very conclusive. Dr. Gosse, of Geneva, the son and grandson of physicians, lost his grown daughter, aged seventeen years. Until 1891 she had remained in perfect health, never having shown the least sign which would lead one to suspect the existence of tuberculosis, but towards the beginning of 1893 she commenced to waste away, and finally died. Dr. Gosse had the courage to make a post-mortem examination, and recognized the existence of intestinal and mesenteric tuberculosis. A careful inquiry into the source of the disease excluded entirely any suspicion of heredity, but brought out the fact that the girl was very fond of drinking milk directly from the cow, on a farm possessed by

the family. The cows were tested with tuberculin, and four out of five showed the disease, and amongst these at the post-mortem examination, two were found to have tuberculosis of the udder.

Professor Law states that, after a lecture at Providence, R. I., a gentleman of North Hadley, Mass., publicly stated that his only child, a strong and vigorous boy of one and a half years, went to an uncle's for one week and drank the milk of a cow which was shortly after condemned and killed in a state of generalized tuberculosis. In six weeks the child was noticably falling off, and in three months died of tuberculosis of the abdomen. There was no tuberculosis on the father's side but some on the mother's, although she herself was in perfect health. Brouardel cites a case where five out of fourteen young girls living together in a boarding house, became consumptive subsequent to the daily use of milk from a tubercular cow.

Professor Woodhead has recently stated that "from his experience in two large hospitals he has been much struck by the fact that in children who have died from other diseases during the course of tubercular disease of the abdominal glands, there was frequently not a trace of tubercular disease in other parts, thus pointing to the intestine as a channel by which the bacillus made its way into the body." He also remarked that in a large number of cases of general tuberculosis where the possibility of the infection by the pulmonary passages was evidently excluded, the tubercular process appeared to have invaded the body by the intestinal canal. These facts taken in connection with the occasional existence of tubercle bacilli in milk, went far to prove, in his opinion, that milk was a source of tubercular infection, especially to young children. He found that out of 127 cases of tuberculosis in children, the mesenteric glands showed tubercular infection in 100, and that there was ulceration of the intestine in 43. Children being such large consumers of milk, and milk forming such an essential part of their diet, it is hard to avoid the conclusion that milk is to them a frequent source of infection.

Still more recently Dr. Demme has published an observation strongly indicating the infection of infants by the digestive tract. Three very young children under the care of a dry nurse and without tuberculous ancestors died during their first year of life of a primary intestinal tuberculosis, proved by a post-mortem examination. A fourth child placed under the same conditions in the house of this nurse died also, and at the autopsy there were found tubercular lesions of the small intestines, with tuberculosis of the mesenteric glands. The other organs were sound. An examination of the nurse showed the existence of a tuberculous affection of the right jaw communicating with the mouth by a fistula. She was in the habit of taking into her mouth pap prepared for the children to test

the temperature of it before giving it to them, and it is altogether probable that the infection of the children took place by the pap through the saliva of the nurse which contained tubercle bacilli.

The frequency with which intestinal tuberculosis is met with in children varies in different places. Dennig states that in Tubingen it is seldom seen, which he explains by the fact that either cooked milk or goat's milk is generally used, the goat being naturally immune to tuberculosis. In Tubingen intestinal tuberculosis occurs in 14.7 per cent. of cases, while in Kiel it is placed by Simmonds at 31 per cent., and by Bolz, in a later estimate, at 41.3 per cent. In Munich, Biedert estimates it at 31.6 per cent., and Muller at 38 per cent. This variation in frequency indicates strongly a local factor in the production of this type of the disease, such as the greater or less prevalence of tuberculosis in the cattle, which is known to be the case.

Widerhofer gives the following analysis of 418 cases of tuberculosis seen at St. Ann's Hospital for Children.

Total cases of intestinal tuberculosis, ...	101	
Small intestine, ...	44	48 combined with mesenteric tuberculosis.
Large and small intestine, ...	19	
Large intestine, ...	3	
Mesenteric glands, ...	35	

Of these 101 cases the chief situation of the disease was:

Phthisis (chronic infiltration of lung), ...	76 cases.
Tuberculosis of brain and membranes, ...	14 cases.
Acute miliary tuberculosis of lung, ...	8 cases.
Glandular tuberculosis, ...	3 cases.

AGE.

0-1 years, ...	3
1-2 years, ...	3
2-3 years, ...	14
3-4 years, ...	14
4-5 years, ...	15
5-6 years, ...	4
6-7 years, ...	9
7-8 years, ...	8
8-9 years, ...	2
9-10 years, ...	5
Over 10 years, ...	24

This table shows that in the period from 2-5 years intestinal tuberculosis is by far most common. This is the period of life when cow's milk is most largely used as food.

Bang relates the following cases which have come under his observation through inquiries in various parts of Denmark:

"A merchant whose two daughters were chlorotic wished them to drink milk freshly drawn. He procured a fine cow and fed her abundantly, but nevertheless she became tubercular and it was necessary to kill her. A second cow procured in the place of this one, also became tubercular and showed disease of the udder, which was probably tuberculosis. The two girls died of tuberculosis at the ages of 16 and 18 years. The two younger children of the same family have attained the ages of twenty and twenty-four years and are in perfect health." "A healthy cow became tubercular after having been placed in the same stable in which another had died of tuberculosis. A child which had been fed almost exclusively on the milk of these two cows became scrofulous and died of tuberculosis." "A peasant of Silkeborg, drank freely of milk freshly drawn. He died of tuberculosis, and almost at the same time a cow succumbed to the same disease in his stable, and a little later a pig. Another peasant who drank milk died of tuberculosis, and the disease was found to be widespread among the cattle of his farm." * * * * * "A peasant owned a cow aged 11 years which was profoundly diseased with tuberculosis of the lung and of the udder. According to the owner she had coughed since she was three years of age. Another cow three years old placed in the same stable also became tubercular, but in a less degree. The wife of the peasant, who had been in perfect health until this time, became tuberculous and died at the age of forty-five years. Soon after, his daughter became sick and died during the same year, also of tuberculosis. These two deaths both took place during the year when the tuberculous disease of the udder became evident in the cow. The mother and daughter had used the milk of the cow. The husband drank beer and remained well." * * * * "A physician lost his two children by tuberculosis after having made them drink milk from his own cow, which was tubercular. Neither the father nor the mother nor the grandparents were tuberculous."

One of the most striking and best attested cases showing the infectiousness of milk from tubercular cows, is that reported by Ollivier to the Paris Academy of Medicine. In a boarding house for women, the milk of one cow had been used for some years. The animal was killed and found to have tuberculosis of the udder and of the internal organs. Twelve of the inmates had tuberculosis, of whom five had died, the last one of tubercular meningitis. In none of these cases was there any history of tuberculosis in the families from which they came. In all but one of them there was tuberculosis of the intestinal tract, pointing almost conclusively to infection by food.

Experiments on animals.—Stronger evidence, if possible, of the danger of milk is obtained by experiments on the lower animals. Gerlach, in 1869, was the first to make exhaustive feeding experiments, and to point out the danger of milk, although as early as 1846 Professor Klenke had given the clinical histories of sixteen children who had been fed on cow's milk, all of which pointed to tuberculosis, either of the intestines, glands, skin or bone. Gerlach fed young animals, calves, pigs, rabbits, etc., with milk taken from tubercular cows, and found that some of them rapidly grew thin, and died at the end of a few months, showing at the autopsy an intense tubercular infection of the organs of the abdominal cavity, from which he concluded that milk coming from a tuberculous source could be infectious, and communicate the malady by the digestive tract; and he called attention to the danger arising from the use of such milk, especially for young children. Later he undertook another series of experiments at the Veterinary School of Berlin, on a much larger scale, obtaining almost always the same positive results in 46 feeding experiments. In 1875 Gerlach published a very important work on the transmission of tuberculosis by food, in which he gave a resumé of his work commenced in Hanover in 1866. In addition to showing the danger of the transmission of the disease by the digestive tract he rendered important service in settling the question then under discussion as to the identity of the disease as seen in different animals. With tuberculous material obtained from cattle, he infected pigs, and dogs with tuberculous material obtained from man; pigs with material obtained from chickens; calves with material obtained from monkeys. He concluded that in all these different species and in all the different forms of the disease seen in them there was only one virus, which was transmissible from one species of animal to the other. Previous to this, Klebs, in 1870, produced lesions identical with those of perlsucht in a calf by intra-peritoneal inoculation with tuberculous material obtained from man, and Bollinger, in 1873, produced well marked tuberculosis in goats by feeding them with portions of tubercular lungs of cows.

Kitt also produced tuberculosis in a calf by intra-peritoneal inoculation of the juice of a scrofulous gland from the neck of a man. During the years 1870 to 1873 Gunther and Harms undertook in Hanover ninety-four feeding experiments with animals of widely different species, and with various kinds of tuberculous material, obtaining twenty-four positive results, and seventy negative or doubtful ones.

Tubercle Bacilli may pass into the milk when the udder is free from Tuberculosis.—It was believed by many, and is still held by some that the milk of tubercular cows is dangerous only when the udder of the cow is affected, but in the last few years a great deal of

very strong experimental evidence has been brought forward to disprove this theory. Thus Ernst found tubercle bacilli in the milk of thirty-three per cent. of cows examined by him, in which a careful post-mortem examination showed that while the animals were widely affected by tuberculosis, the udder was free from disease. In 1893, Theobald Smith showed that the tubercle bacillus may be present in the milk of tubercular cows when the udder, so far as the naked eye could tell, was free from disease. The presence of the tubercle bacillus in milk is more readily detected by inoculation experiments, and these confirm the results of microscopic examinations. Hirshberger, by inoculation into the abdominal cavity of guinea pigs with milk of cows whose udders showed no sign of disease, produced tuberculosis eleven times in twenty experiments, a percentage of fifty-five. Bang inoculated from sixty-three tubercular cows, selected for their sound udders, and found the milk of nine of them to be infectious. Subsequent microscopic examinations showed that the udders of three of these cows were tuberculous, leaving six which gave infections milk, in which even after death no tubercles could be found in the udder. Ernst found ten cases out of thirty-five which gave infectious milk, though the udders were sound. Of a hundred and three animals inoculated seventeen contracted tuberculosis, and of twelve calves sucking the cows, five became tubercular. Freudenreich examined twenty-eight samples of mixed milk, and of this number found four which proved to be virulent when inoculated into guinea pigs. Two of these samples came from dairies where from twenty to thirty cows were kept, and where in each case only one cow was suspected of being infected. The other two samples which were more virulent came from dairies where there was more than one suspected cow, and where the udders of some of the animals were visibly tuberculous.

In the reports compiled by Wesener up to 1884, the milk of tubercular cows was experimentally used as food in eighty-six cases, of which three-fourths of the pigs and one-half of the goats became diseased. These experiments, 369 in number, and in which tuberculous material was obtained from different sources, indicate that the tuberculous matter from animals possesses the greatest power of infection; next the sputum of persons suffering from phthisis, and the milk of tubercular animals, and lastly tuberculous flesh.

Experiments in the laboratory of the State Live Stock Sanitary Board.—Experiments conducted in this laboratory during the years 1896 and 1897 for the State Live Stock Sanitary Board of Pennsylvania, have given like results. Five cows which reacted to tuberculin but showed no physical signs of tuberculosis were obtained, the udders in every case being free from disease as far as a careful inspection could reveal. The post-mortem examination

of these cows confirmed the diagnosis made during life, and all of them showed thoracic or abdominal lesions or both. During these experiments the cows were kept under the best sanitary conditions, were carefully fed and groomed, and given as much out-door life as possible in a paddock. Guinea pigs were exclusively used, and the method of inoculation was intra-peritoneal. In no case was any attempt made to concentrate the number of tubercle bacilli in the milk; on the contrary, the whole milking was thoroughly shaken together before being used, the object being to approach as nearly as possible the conditions which would be obtained from ordinary dairy milk.

A single dose averaging ten cubic centimetres was given, and in each case the experiment ended with the death and careful post-mortem examination of the animal. The details of these experiments have been given in a previous publication of this Department, a summary only being presented here.

Series A. Fifty pigs were inoculated, 18 of which died within a few days after the injections, too soon for any signs of tuberculosis to have manifested themselves, and one was lost. Subtracting these, and considering only those which lived long enough for the disease to have become manifest, we have left 31 animals, 4 of which were unquestionably tubercular, a percentage of 12.9.

Series B. Thirty pigs were used in this series, six of which died before tubercular lesions could have become manifest. Subtracting these 24 animals are left, 5 of which were tubercular, a percentage of 20.8.

Series C. Eight pigs were used, and the milk of a single cow was employed. One pig became tubercular, a percentage of 12.5.

In these three series of experiments 88 guinea pigs were used, 63 of which lived a sufficient length of time for the development of tuberculosis after the inoculation, and 10 contracted the disease, a total percentage of 15.8 which became infected by the single dose of milk.

Series D. In this experiment 52 pigs were used. Two were inoculated daily with mixed herd milk, and two with the same milk after sterilization by heat. None of these animals became tubercular. It has not seemed proper to include this series with the others, but the figures are given for the sake of fairness, and also because of the interest they bear. When this experiment began, the cows had been under treatment about eight months, the treatment consisting in the use of large injections of tuberculin, 5 to 10 cc., on an average of every three weeks. All had improved very much and one had gained more than 100 pounds in weight. In all these experiments it must be remembered that no attempt was made to collect the

bacilli in a small quantity of fluid, but on the contrary they were distributed as thoroughly as possible before the inoculation.

From these experiments it is fair to conclude that the number of bacilli in the milk of tubercular animals may vary from day to day, although in taking ten centimeters from the whole mass of milk we may have have missed bacilli which were present in small numbers. Additional evidence is afforded that the bacillus of tuberculosis may pass into the milk of cows having general tuberculosis, but whose udders are perfectly healthy, so far as the most careful examination during life or after death can show.

These last experiments seem to settle the question conclusively as to the possibility of milk being infectious, even when there is no lesion of the udder either macroscopic or microscopic that can be found during the life of the animal, or after death. That the milk from cows in which there is evident disease of the udder is virulent is beyond controversy, and is admitted by all who have studied the subject at all. In speaking on this point in the report of the Royal Commission of Tuberculosis in 1895, Dr. Martin writes: "The milk of cows with tuberculosis of the udder possesses a virulence which can only be described as extraordinary. All animals inoculated showed tuberculosis in its most rapid form."

Dr. Woodhead, who studied the effects of unboiled milk, speaks in similar terms of milk taken from tuberculous udders. Butter and skimmed milk and butter milk obtained from the milk of cows having tuberculous udders were all found to contain tubercle bacilli. Dr. Woodhead also calls attention to the rapidity with which at times the udders of cows affected with tuberculosis in other parts of the body may become diseased. In several cases he detected tuberculosis of the udder that had developed between the fortnightly visits of the veterinarian who was engaged with him in these experiments. Both he and Dr. Martin insist strongly that no cow having tuberculosis of any part of the body should be retained in a dairy. Apart from the fact that a local tuberculosis may become generalized very rapidly, the fact, as before shown, that the milk of cows suffering with general tuberculosis but having no local disease of the udder, may contain the tubercle bacillus, would convince one of the danger of retaining such cows in a dairy.

In regard to the danger of milk from tubercular cows, it is the opinion of some of the best authorities that no danger exists or can exist unless there is disease of the udder. Galtier, who has never been able to find virulent milk except where the udder itself has become diseased, says: "Nevertheless, as commencing tuberculous disease of the udder is difficult to recognize, especially in the living animal, we should consider as dangerous, the milk of all cows known to be tubercular or even suspected of being tubercular. We ought

to absolutely avoid the consumption of milk from cows in which the udder is tuberculous, and to boil before using, the milk of all cows affected or suspected of tuberculosis in any form. Finally, we should never consume without having previously boiled, milk of which we do not know certainly the origin, and especially we ought in cities not to omit taking this precaution in regard to milk furnished by milkmen."

Nocard, who is of the opinion that cows never yield tuberculous milk unless there is disease of the udder, speaks as follows on this point: "It is possible that in the cases where the suspected udder does not appear to be tuberculous that the lesion has not been sufficiently sought for, to say nothing of the cases where the tuberculous follicles are still in the embryonal stage and not yet visible to the naked eye. It is not hard to understand the difficulty of making the search for these seed-like tubercles among the glandular acini when these tubercles have not yet undergone calcareous degeneration."

Rabinowitsch and Kempner inoculated the milk of 15 cows into guinea pigs, the experiment being made to determine whether or not the milk of cows having a tuberculosis which could be detected only by tuberculin, and not by physical examination, might be virulent. Three examinations were made by a veterinarian during the course of the experiment. Of the 15 animals, 10 were found to give virulent milk, a percentage of 66.6. One cow gave milk which contained yellowish gelatinous material, and caused a fatal peritonitis in all animals inoculated. Leaving this out, the positive results amount to 71.4 per cent. All of the cows had reacted to tuberculin, but none showed clinical evidence of udder disease when the experiment began. Of the ten giving virulent milk, three showed advanced general tuberculosis, but no disease of the udder; two showed no evidence of disease at all, and one only on the second and third examinations. One cow had rales at time of first examination, but these disappeared and she showed no evidence of disease after. On postmortem one cow was found to have tuberculosis of the udder, and one showed clinical evidence of it on the third examination made six months after the experiment was begun. The authors conclude: "Milk may contain tubercle bacilli, first, in beginning tuberculosis without discoverable disease of the udder, and second, in latent tuberculosis that can be detected only by the tuberculin reaction." Also, "Milk from cows that react to tuberculin must be suspected of being infectious in every case."

Tubercle Bacilli in butter, cheese, etc.—It has also been shown experimentally that tubercle bacilli will retain their life in butter for upward of one hundred and twenty days and in cheese for eleven months. Numerous observers, such as Obermüller, Galtier, Heim, Laser, Bang, Roth, Groening, Gasperini and Petri, have shown that

the tubercle bacilli may be contained in all the products of milk, cheese, butter, whey and skim milk. Several of them have found the tubercle bacillus in butter bought on the open market. Others have taken milk, and from it made the butter, and so forth, with which they did their experiments, while others have taken good milk and infected it artificially with pure cultures of the tubercle bacillus, and from it made the products with which they experimented. We may, from these experiments, state positively that butter, cheese and whey made from milk which contains the tubercle bacilli, whether these bacilli came direct from the diseased cow, or are added artificially, will also contain the germs and be virulent for animals.

But one piece of work which has come to my knowledge militates against this general experience. Lydia Rabinowitch claims that of eighty samples of market butter examined in Berlin and Philadelphia, in no one of them was the genuine tubercle bacillus found, though in twenty-three she obtained an organism closely resembling the tubercle bacillus in its staining peculiarities and its morphology, but on culture showing different characteristics. This work has not been confirmed entirely by anyone, and has been opposed by the latest work of Petri at Berlin, who has found in a number of cases the organisms described by Rabinowitsch but in a large percentage of cases has found also the true tubercle bacillus. Petri examined 102 samples of butter, using 408 animals for inoculation. Of these he found 31 samples or 30.4 per cent. to contain neither the true tubercle bacillus nor the new bacillus. Seventeen samples, or 16.7 per cent., contained the true tubercle bacillus alone; 16 samples, or 15.7 per cent., contained both organisms, while 38 samples, or 37.2 per cent., contained only the new bacillus. From this it will be seen that the true tubercle bacillus was found in thirty-three samples, or 32.3 per cent. of all, while the new bacillus was found in fifty-four samples, or 52.9 per cent. Petri also examined sixty-four samples of market milk bought in different parts of Berlin, using 478 animals for inoculation. In nine samples, or 14 per cent., he found the true tubercle bacillus, while in four samples, or 6.3 per cent. the new bacillus was found. In fifty-one samples, or 79.7 per cent., neither was present. He infers from his work that Rabinowitsch has probably mistaken the true tubercle bacillus in many cases for this organism resembling it so closely; since, according to her, the subsequent inoculations of pure cultures of the bacillus only misled one further, as the lesions produced in animals closely resembled true tuberculosis, though she claims that on microscopic examination the minute structure of the lesions proved that they were not the genuine disease. Petri finds on the contrary that subsequent inoculations with this germ, so closely resembling the true tubercle bacillus, produce a local change only, from which the animal soon

recovers, and which is not likely to be mistaken for tuberculosis. Certainly the work of Rabinowitsch is not conclusive enough to negative the work done by so many competent observers the world over, who have found that butter may contain the true tubercle bacillus.

The publication of the result of Rabinowitsch and the sweeping conclusion drawn, led a number of observers to study the question anew. Hormann and Morgenroth examined ten samples of butter, using the method of intra-peritoneal inoculation in guinea pigs. Three samples contained true and virulent tubercle bacilli, as proven both by the lesions produced and by cultures. In two the tubercle-like bacillus was found. They conclude that "It is shown that it is not rare to find the true tubercle bacillus in butter." Obermüller also examined ten samples of market butter by the same method, seven of which he found contained virulent tubercle bacilli. In all cases the identity of the organisms was proven by macroscopic as well as by microscopic examination of the lesions produced, and in most instances cultures were also obtained. He considers that it is by no means rare for the butter sold in cities to contain tubercle bacilli. Korn has recently examined 20 samples of butter bought in the markets of Freiburg. Three of these coming from the same source caused a rapidly fatal peritonitis in the animals inoculated. Of the remaining 17, virulent tubercle bacilli were found in 4, or 23.5 per cent. The diagnosis was made by the lesions, which were marked, and also by cultures. Rabinowitsch has made a second study of market butter, bought in Germany. Fifteen samples were examined and in two coming from the same source, virulent tubercle bacilli were found. At three different times in June, July and October the butter from this establishment was examined, and each time proved virulent. She draws the somewhat curious conclusion that it is exceptional to find true tubercle bacilli in butter.

Margarin.—At the suggestion of Prof. Rubner, of Berlin, Morgenroth has examined a number of samples of "margarine." In the manufacture of this substance, fat from the mesentary and mediastina is said to be employed, and this fat often contains tuberculous glands. It is also mixed with milk at one stage of the process, and at no time is a degree of heat which is fatal to the tubercle bacillus used. He examined 20 samples, some of which were of the cheap variety and some expensive. In 9 specimens true tubercle bacilli were found.

There are at least two other means by which tubercle bacilli may find their way into the milk even without disease of the udder. First, the cow may convey them to the outside of the udder in her sputum by means of her tongue, and from the outside of the udder the germs may find their way into the milk.

Secondly, Gaffky has shown the possibility of the infection of the milk by means of the discharges from the bowels. The fecal mat-

ter, even when there is not a diarrhoea, in tubercular cows frequently contains bacilli in considerable numbers and infection of the outside of the udder by this means is easy.

Hirschberger estimates from his observations that ten per cent. of cows in the neighborhood of towns are affected with tuberculosis and of these one-half yield milk containing tubercle bacilli.

The danger in the use of the flesh of tubercular animals.—The question of infection by means of tuberculous meat is one of very great interest both from a hygienic as well as an economic standpoint. Chauveau, as already mentioned, pointed out the use of meat as a possible source of infection for man, and Gerlach emphasized this at the time of his experiments on milk. But in 1880 Toussaint raised the greatest alarm by the result of his experiments, according to which, not only the parts of the body which were infected by tuberculosis were dangerous, but also the most diverse products taken from tubercular animals, such as the blood, the juice of the muscles, the nasal secretion, the saliva, the urine, the serous matter of vaccine pustules, all of which he found were virulent and capable of transmitting the disease. We are certain now that Toussaint made experimental errors, and that such is not the case, but in spite of this, there have been several careful and able men who have urged the total destruction of the entire carcass of any animal affected with tuberculosis in any degree whatever.

Since Toussaint's work, many experiments have been tried with the result that we now know that in a great majority of cases, only the tubercular lesions themselves possess any virulence, or power of transmitting the disease. It must be remembered, however, that any part of the body, however harmless it may be of itself, may become dangerous by admixture with matter coming from a tuberculous area. Such danger, for instance, has been pointed out by the Royal Commission for Tuberculosis for 1895, who showed that by carelessness the butcher might cut through a softened and purulent gland, or area in an organ, and with the same knife cut through other parts of the body; so that while it has been shown that the muscular tissue itself is seldom invaded by tuberculosis, it may become soiled and infected by material from other parts of the body, which may be richly laden with tubercle bacilli. Without doubt there are moments in the life of most tubercular animals when their blood becomes infected with the tubercle bacilli through the breaking down of some diseased gland or nodule by which means a flood, so to speak, of germs is thrown into the general circulation, and thus carried to every part of the body. Numerous observers, such as Wiechselbaum, Rutimeyer, Meisel, Lustig, and others have at times found tubercle bacilli in the blood of men suffering or dead from acute generalized miliary tuberculosis; but the experiments of Nocard,

Bang and others have shown that this virulence of the blood, as far as animals at least, are concerned, is only temporary, and that in a few hours at most, the blood rids itself of all tubercle germs, which are deposited in the different organs where they find surroundings suitable for their growth and multiplication; and it is believed by Nocard that those germs lodging in the muscles are rapidly destroyed by a special destructive action which the muscular tissue has on the tubercle bacillus. His experiment, which was reported at the tuberculosis congress of 1888, was as follows. He injected into the auricular vein of a rabbit, one cubic centimeter of a culture rich in tubercle bacilli. At the end of six hours even, blood drawn from the jugular vein of this rabbit and sown in glycerine bouillon gave no development. Some of the same blood was inoculated into the aural vein of another rabbit, which remained perfectly well, and when killed at the end of three months showed no trace of tuberculosis. He also showed by similar experiments that the juice extracted from the muscles of rabbits which had received an injection into the circulation, had no virulent properties at the end of from four to six days.

Bang, in 1891 at the Hygienic Congress of London, reported the following experiment:

The blood of twenty cows far gone in tuberculosis was defibrinated and then inoculated into thirty-eight rabbits and two guinea pigs by intraperitoneal injection, the dose varying from ten to eighteen centimeters. The result was eighteen negative cases and two positive ones, and of these two positive cases only one of the two rabbits inoculated showed marked tubercular lesions. In the other they were very insignificant. The cow which gave virulent blood was affected by an acute miliary tuberculosis. Three weeks before he had injected the blood of this same cow, and found it then nonvirulent. Among the eighteen negative cases there were several of acute miliary tuberculosis. Nocard states that he has never succeeded in producing tuberculosis in animals by intraperitoneal injection of blood collected purely from tubercular cattle. At the tuberculosis congress of 1888 the question of the danger of the use of meats coming from tubercular animals was made the subject of discussion. Nocard gave the following results of his experiments in regard to the meat of tubercular cows:

From twenty-one animals with generalized tuberculosis, the most of which had been condemned and seized at the abattoir, he took, with care, pieces of muscle from the centre of the large adductor muscles of the thigh. The juice of these muscles was squeezed out with the aid of a press and inoculated into the peritoneal cavity of guinea pigs in doses of one cubic centimeter. Only one guinea pig out of 84 contracted tuberculosis. Nocard has also fed a number of kit-

tens with the meat of cattle seized at the abattoirs of Villette and Grenelle on account of generalized tuberculosis, without ever having produced tuberculosis in a single one. Contrasted with this, the control cats to which he fed small pieces of the lung, of the liver, or of the diseased glands, have died of adominal tuberculosis in from six weeks to five months. He relates as the most convincing of all of his experiments, the following: Four cats born the 4th of March, 1888, have eaten on four occasions (the 10th and the 15th of April, and the 3d and the 8th of May, 1888), each two kilograms of raw chopped meat taken from the muscles of the leg of cows seized on account of generalized tuberculosis, and none of these animals became tubercular. The juice of the identical muscles when inoculated into the peritoneal cavity of guinea pigs produced tuberculosis in one out of four animals inoculated. In this case the presence of tubercle bacilli in the muscles was proven by inoculation and yet these young animals, which ever since the experiments of Viseur, we have known are quite susceptible to inoculation by the digestive tract, escaped the disease entirely. From these and other like experiments, Nocard draws the following conclusion:

"The meat of tubercular animals may be in certain cases dangerous, but it is exceptional and in such event only so in a very small degree." This, manifestly, does not relate to meat that has been contaminated by tuberculous material from glands and organs that may have been smeared on it in the slaughter house or butcher shop.

Galtier reports later experiments published in 1892. "A calf aged six weeks ate in one month four kilograms of raw meat taken from cows which had been seized on account of generalized tuberculosis. Another calf aged from four to five months also ate at three different times large quantities of raw tuberculous meat. At the postmortem none of these animals showed the least trace of tuberculosis. Two young pigs aged five to six months ate with impunity considerable quantities of condemned meat (2 kilograms on the 26th and the 27th of February, 3 kilograms on the 14th and 15th of March, 3 kilograms on the 24th and 25th of March and 2 kilograms on the 27th and 28th of March)." These four animals, which were of a species which we know to be susceptible to tuberculosis and at an age which renders them especially so, were able to eat at different times large quantities of tuberculous meat, and yet none of them contracted the disease. The experiment is especially interesting since of the 14 samples of meat which were used, two had been proven to contain tubercle bacilli by the inoculation of rabbits with the expressed juice.

Perroncito has also published like experiments in which he fed 18 young pigs for 3, 4 and 5 months with meat taken from tuber-

cular animals condemned at the abattoir of Turin without producing tuberculosis in any of them. He made also extensive experiments with the expressed juice of meat taken from tubercular animals, with negative results. Of more than 200 guinea pigs and as many rabbits, inoculated into the peritoneal cavity or subcutaneously, with this juice, none became tubercular. Two bovines inoculated under the skin were found perfectly healthy when killed after six months.

Views of Koch.—The opinion of Koch on the danger of using the meat and milk of tubercular animals is of interest. He says: "We may conclude that infection by the use of meat of tubercular animals is exceptional. Without doubt it would occur more frequently if persons were not careful, as is the general case, to reject the parts visibly diseased, and also if the meats were not subjected to cooking, as is also the common practice. It must be remembered that tuberculosis of animals used for food, and especially in beef cattle, remains ordinarily more or less localized, so that the eating of the lungs or diseased glands, etc., alone is dangerous. However, infection by the digestive tract is possible, as is proved by the numerous cases of secondary tuberculosis of the intestine, observed in people suffering from consumption, a condition which certainly arises from autoinfection through swallowing sputum. Intestinal ulceration is not observed in all tubercular people, although all of them to a greater or less extent swallow their virulent sputum. This is explained without doubt by the fact that the digestive tube is not so favorable a soil for the development of the tubercle bacillus, which is naturally slow, as is the respiratory tract. The same considerations hold good concerning infection by the milk of tubercular cows. For this infection to be possible it is necessary that the milk must contain the germs, which appears only to happen when the udder itself is tubercular. As tubercular nodules are only met with infrequently in the udder, milk of tubercular cows ought often to be devoid of infectious properties. In this way are to be explained the contradictory results obtained by those who have made feeding experiments with the milk of tubercular cows. Some claim to have had positive results, which one can scarcely doubt—others never succeed in infecting animals, and these negative results can no more be attacked. The positive results have been obtained with milk containing bacilli; the others with milk which, although coming from a tubercular cow, did not contain them. Although the infection of man by the domestic animals suffering from tuberculosis does not appear to occur frequently, we should not look at the question as being a trivial one. Tuberculosis of cattle, and the caseous alterations of the lymphatic glands in pigs, are so frequently met with that the question deserves the greatest attention."

Bang's experiments have led him to conclude that the muscular tissue is a poor soil for the life and multiplication of the tubercle bacillus. He considers that the seizing of the meat of all animals suffering from tuberculosis is too severe. "As long as the tuberculosis is clearly localized the meat offers no danger. Danger begins when the disease is generalized, but even then it does not appear to be very great. It is necessary to avoid eating raw or badly cooked meat."

Report of Royal Commission.—I quote from the report of the Royal Commission on Tuberculosis, issued in 1895, some results which are of considerable interest and practical value. Their investigations were extensive, thorough, and carried out in a true scientific spirit of inquiry, with no preconceived prejudices or opinions. It will be noted that they say that tuberculous matter is "seldom or never found (in milk) when the udder is not diseased." From the experiments quoted in this paper, as well as the work done in the laboratory of the State Live Stock Sanitary Board, which is reported separately, it will be seen that we cannot at all agree with this opinion, since it appears to us to be proven beyond question that milk may be virulent for animals even when there is not the slightest disease of the udder that can be detected by the most careful examination, either during life or post-mortem.

The following were among the conclusions of the Commissioners: "We have obtained ample evidence that food derived from tubercular animals can produce tuberculosis in healthy animals. The proportion of animals contracting tuberculosis after experimental use of such food is different in one and another class of animals; both carnivora and herbivora are susceptible, and the proportion is high in pigs. In the absence of direct experiments on human subjects we infer that man also can acquire tuberculosis, by feeding upon materials derived from tubercular food animals.

"The actual amount of tubercular disease among certain classes of food animals is so large as to afford to man frequent occasions for contracting tubercular disease through his food. As to the proportion of tuberculosis acquired by man through his food or through other means we can form no definite opinion, but we think it probable that an appreciable part of the tuberculosis that affects man is obtained through his food.

"The circumstances and conditions with regard to the tuberculosis in the food animal which lead to the production of tuberculosis in man are, ultimately, the presence of active tuberculous matter in food taken from the animal, and consumed by man in a raw or insufficiently cooked state.

"Tubercular disease is observed most frequently in cattle and in swine. It is found far more frequently in cattle (full grown) than

in calves; and with much greater frequency in cows kept in town cow houses than in cattle bred for the express purpose of slaughter. Tuberculous matter is seldom found in the meat substance of the carcass; it is principally found in the organs, membranes and glands. There is reason to believe that tuberculous matter, when present in meat sold to the public, is more commonly due to the contamination of the surface of the meat itself. The same matter is found in the milk of cows when the udder has become invaded by tubercular disease, and seldom or never when the udder is not diseased. Tuberculous matter in milk is exceptionally active in its operation upon animals fed either with the milk or with the dairy produce derived from it. No doubt the largest part of the tuberculosis which man obtains through his food is by means of milk containing tuberculous matter.

"Provided every part that is the seat of tuberculous matter can be avoided and destroyed, and provided care be taken to save from contamination by such matter the actual meat substance of a tubercular animal, a great deal of meat from animals affected by tuberculosis may be eaten without risk to the consumer.

"Ordinary processes of cooking applied to meat which has gotten contaminated on its surface are probably sufficient to destroy the harmful quality. They would not avail to render wholesome any piece of meat that contained tuberculous matter in its deeper parts. In regard to milk we are aware of the preference of English people for drinking cow's milk raw, a practice attended by danger, on account of possible contamination by pathogenic organisms. The boiling of milk, even for a moment, would probably be sufficient to remove the very dangerous quality of tuberculous milk."

Decrease in death rate from consumption of the lungs.—The statistics brought out by the Commission show a very gratifying decrease in the total death rate from consumption, which has been noticed in many parts of the world, and on this fact some persons have attempted to base an argument against the danger of meat and milk from tubercular animals. However, so far from supporting this idea, when carefully considered the figures give most striking evidences of the dangers of such food, at least as regards milk, for the decrease applies only to phthisis, the form of tubercular disease most fatal to adult life, while "tabes mesenterica," which is seen almost entirely in children, has undergone but little, if any, reduction for the period of life from 0 to 5 years, when children are fed most largely on milk. In fact, Sir Richard Thorne states that for the first year of life there has been an increase in death rate from tabes mesenterica of no less than 27.7 per cent.

Action of gastric juice on the Tubercle Bacillus.—In considering infection through the digestive tract the question of the action of the

gastric juice on the germ of tuberculosis naturally arises, the gastric juice being known to possess a certain degree of antiseptic power. This has been studied by Falk and by Wesener, both of whom, however, used an artificially prepared gastric juice. Falk subjected caseous material taken from the lungs of man to the action of an artificially prepared gastric juice, made by the mixture of pepsin with dilute hydrochloric acid. After remaining in this fluid for a number of hours (the exact number not stated by the author), the material was inoculated into guinea pigs, all of which became tubercular.

Wesener used tuberculous sputum, keeping it in artificial gastric juice at a temperature of 38 degrees for a number of hours, after which he injected it in the cæcum of rabbits, producing tuberculosis of the intestine. In five other cases where inoculation was practiced, positive results were obtained. Cadeac and Bournay, whose experiments were done by introducing fragments of tubercular lungs into the stomach of a dog, found that twelve hours after ingestion of such material the bacilli remained virulent.

Strauss and Wurtz have done the most complete work on this subject. They employed natural gastric juice obtained from a healthy young dog by means of a gastric fistula. This gastric juice was tested and found to be very active in the digestion of the cooked white of egg. They used pure cultures of the tubercle bacillus grown on glycerine agar, and subjected the germs to the action of the gastric juice for periods of time varying from one hour to twenty-four and thirty-six hours, the cultures then being inoculated into the subcutaneous tissues of rabbits and guinea pigs, or else into the peritoneal cavity. By this means they found that those cultures which had remained up to six hours in the gastric juice were not in any way altered. It must be remembered that under natural conditions, such as the ingestion of meat or milk containing tubercle bacilli, the action of the gastric juice would be lessened considerably by the presence of other material which would afford protection to the tubercle bacilli. The period of gastric digestion, moreover, does not usually extend to six hours. In the experience of Strauss and Wurtz the bacilli were entirely naked, so to speak, and exposed to the full action of the gastric juice, and from their survival under these circumstances we are justified in concluding that the germs contained in food may readily pass through the stomach without injury. It must also be remembered that infection can and often does take place before the stomach is reached through the tonsils and through the mucous membrane of the mouth and pharynx. Cadeac believes that in the guinea pig the principal mode of infection by ingestion is through the mucous membrane of the mouth and pharynx. Likewise lesions

of the cervical glands have been observed in the calf by Chauveau and many veterinarians, in the rabbit by Orth, in the cat by Viseur, and in the pig by Toussaint, and by numerous meat inspectors.

In addition to the evidence given above we have conclusive proof of the possibility of infection by means of the digestive tract, through observations made on persons suffering from pulmonary tuberculosis, in whom a secondary tuberculosis is not infrequently set up by the swallowing of their own sputa. Furthermore, it has been experimentally shown by the inoculation of animals into the intestine below the stomach, that the disease may be readily set up through this avenue of infection.

In the foregoing pages I have attempted to give a fair and impartial view of the discussion which has taken place on this most important subject, and while it has been my aim to call attention to the real dangers which must be guarded against, I have avoided any exaggeration of them. They are great enough without having anything added to them. From a purely scientific standpoint it would seem to be safest to absolutely condemn all food products coming from tubercular animals, but the extreme severity of such measures would cause their failure, and we have at our hands means by which these dangers can be lessened or entirely avoided. The economic point of view and the laws which have been generally accepted by other nations of the world as being advisable, as well as the extent of the disease in milch and beef cattle, is discussed in another part of this report.

Precautions to be taken in use of food products from tubercular animals.—It may be said positively that the use of all products coming from animals affected with tuberculosis, as well as the slaughter and preparation of such animals for food, should be under some sort of supervision, and that people wishing to use such products should exercise personal care. For meat, such care consists mainly in the discarding of visibly diseased parts, and of all internal organs of all animals showing any signs of the disease; and further taking care that all portions consumed as food should be thoroughly cooked before eating. It has been shown by Doctors Martin and Woodhead that the tubercle bacillus is not destroyed in the centre of a joint of meat over six pounds in weight by the ordinary method of cooking. Care should be exercised by the butcher to avoid the contamination of healthy portions of the carcass by means of his knife which has been used in taking out the viscera or in cutting through diseased tissues. As far as milk goes, the sole precaution necessary is in boiling, or at least, pasteurization, by which is meant the employment of a degree of heat sufficient to kill the tubercle bacillus without producing the boiled milk taste, which is objectionable to

many. In practice as applied milk, the degree of heat to be used is limited by the production of the "boiled milk" taste, which becomes permanent at about 70 degrees C. (158 degrees F.); while, on the other hand, it must be sufficient to kill the tubercle bacillus, which is the most resistant of the disease producing germs likely to be found in milk. This bacillus is killed by a temperature of 68 degrees C. (155 degrees F.), after an exposure of fifteen minutes; hence, for perfect safety, we heat milk to 70 degrees C. (158 degrees F.), for twenty minutes and then cool it rapidly. Under proper precautions we are safe in employing a lower temperature even, Russell recommending 140 degrees F. (60 degrees C.), for not less than 20 minutes in a closed Pasteuriser. (See Chapter VI, p. 107.)

Salt meats may contain living Tubercle Bacilli.—It must be remembered also that salt meats are not free from danger, as the experiments of Galtier, Foster and others have shown. These, as well as fresh meats, should be thoroughly cooked before eating.

Jews less often affected by Tuberculosis than other races.—It is interesting to observe as corroborative evidence of the usefulness of laws against diseased meat, the partial immunity enjoyed by the Jewish race. It is probably due in part, at least, to the care which is taken in the inspection of their meat supply, and partly also to the fact that much of their cooking is done in fat. This immunity is quite marked, as the following figures show. For the six years ending May 31, 1890, the average annual death rate from consumption in the city of New York per 100,000 of population was:

For the Irish,	645.73
For the colored,	531.35
For the Germans,	328.80
For the American whites,	205.14
For the Russian-Polish Jews,	76.72

(J. S. BILLINGS.)

In a paper recently read before the Jewish Board of Guardians in London, Dr. Gaster gives statistics based on the burial returns of the United Synagogue, from 1889 to 1893, as compared with those of the Registrar-General, which go to show that Jews suffer from tuberculosis only about one-half as often as non-Jews.

Infection by inhalation.—Apart from the infection which may arise from the consumption of diseased products there is yet another danger to man, which, though it may be limited in extent, is not to be overlooked, for even if only one person here and there should become diseased from this source, it must be remembered that each consumptive individual is in himself a source of infection from which many may suffer. Tuberculosis by inhalation, commencing

primarily in the pulmonary apparatus, is acknowledged to be the most common mode of infection for grown persons and by some observers is believed to be so for young children also. Numerous experimenters using various products containing the tubercle bacillus, in both the dry and the wet state have succeeded in producing the disease by inhalation. The first of these experimenters was Tappeiner, who, in 1877 and the year following, succeeded in inoculating dogs, which are exceedingly exempt from spontaneous tuberculosis, by way of the respiratory tract. His method was to thoroughly mix a small amount of tuberculous sputum in water and then by means of an atomizer, spray it into the rooms in which the dogs were kept. A number of other men did like experiments with quite a number of positive results. Koch, after the discovery of the tubercle bacillus, tried similar experiments, using only pure cultures, of which he made a fine suspension in distilled water, and then sprayed this mixture by means of an atomizer into the boxes containing the animals. All the animals used in this experiment showed tuberculosis of the lungs. Quite recently, the question having been raised by Flügge as to the infectious character of dry tuberculous sputum, Cornet has carried out the following experiment: He placed tuberculous sputum on a piece of ordinary carpet and after having allowed it to dry, he put guinea pigs in the room, some on the floor, others on shelves at different heights above the floor, 7, 40 and 120 centimeters ($2\frac{3}{4}$, $15\frac{3}{4}$ and 47 inches). He then entered the room, having protected his nose and mouth by means of cotton wadding, and with a broom swept the carpet in such a way as to break up and distribute the dry tuberculous sputum. Other pigs were subjected to direct inhalation of air charged with the pulverized sputum. Of 48 guinea pigs used in this experiment, 46 became tubercular. It is universally accepted that dried tuberculous sputum is the most common means of disseminating tuberculosis, but it is not the only means. It has recently been shown by Klebs that during the act of coughing, small particles of tuberculous matter are projected from the mouth in a pulverulent condition much in the manner that would be accomplished by means of an atomizer. These particles he collected by means of a piece of glass held in front of the patient. Such particles of matter no doubt will remain suspended in the air of an ordinary room for some time and may be carried considerable distances by very slight currents of air.

The dissemination of Tubercle Bacilli by cows in coughing.— I have been able to show that the same thing holds true in tuberculosis of cows. The widely accepted opinion that cows swallow all of their sputum and do not project it to any great extent, is erroneous. Various methods for the collection of sputum from the

trachea and larynx of cows have been tried with the idea of using the examination of their sputum for diagnostic purposes. Pöls proposed the insertion of a canula into the trachea for the collection of mucus, but it has not proved satisfactory. Nocard has suggested the injection of veratrine or eserine in order to increase the secretion of the bronchial tube, but this has likewise been unsuccessful. The use of a swab inserted down the trachea, as proposed by Groffier, has given better results. A more simple method and one easily carried out, has been tried at this laboratory, which consists in the use of an ordinary nose bag, near the bottom of which is placed a shelf of soft pine wood. The smallest particles ejected by the cow during the act of coughing are caught by this soft pine wood and may then be transferred to a cover slip and examined under the microscope. By this means I have been able to detect tubercle bacilli in the bronchial secretion of every tubercular cow in which it has been tried. In one animal the amount of secretion was exceedingly minute and even after the nose bag had been kept on her for three to four hours, there would often be only a few particles of matter, not larger than the head of a pin, but they were almost always exceedingly rich in tubercle bacilli. In this way what might be expected theoretically has been practically demonstrated by our experiments, namely, that in the act of coughing, cows, as well as men, atomize, so to speak, their sputum and project it into the air in minute particles which may float for a considerable time. Secretion collected in the same way has been inoculated into the peritoneal cavity of guinea pigs and even when the bacilli could not be demonstrated under the microscope, a large proportion of positive results have been obtained.

Of 34 examinations carried out on 5 different animals, tubercle bacilli were detected by microscopic examination 20 times. The number of bacilli found varied greatly, but one of the five animals constantly coughed up a tenacious mucus in which the numbers approached those seen in human sputum from advanced cases.

During a period of time extending over forty-three days, mucus from two cows was collected by means of the nose-bag on eighteen days, and inoculated into the peritoneal cavity of 45 guinea-pigs. Of these 23 died within a few days, most of them from peritonitis, at a period too early for the development of tubercular lesions. Subtracting these, we have remaining 22 animals, 11 of which, or 50 per cent., became markedly tubercular.

Furthermore, there is some danger from the bacilli contained in the feces. We have demonstrated that the feed boxes of cows suffering from tuberculosis are contaminated by their saliva and nasal secretion. We have been able to produce tuberculosis in guinea pigs by inoculation with the scrapings of the feed boxes. Practical experience has shown that similar inoculation of cows in stables takes

place. "Nothing is more common in an infected stable than to see a healthy cow become sick some time after occupying the stall vacated by a tubercular animal."

Accidental inoculation of man.—Another but less frequent danger to man from diseased cattle is by direct inoculation, which also tends to prove the identity of the disease as seen in man and in animals. A few such instances may be cited showing direct transference of the disease from cattle to men.

Tscherning, of Copenhagen, attended a veterinarian who had cut his finger in making a post-mortem examination upon a tubercular cow. After healing, the wound began to ulcerate, and the growth was finally removed. Microscopic examination revealed a tuberculous process with the presence of the tubercle bacilli.

Pfeiffer attended a veterinarian thirty-four years of age, with a good constitution and without hereditary predisposition, who cut his thumb in making a post-mortem examination on a tubercular cow. The wound healed, but six months later the cicatrix still remained swollen, and in the fall of the next year the man developed pulmonary tuberculosis, bacilli were found in his sputum, and death occurred two and a half years after the wound. Post-mortem examination revealed tuberculosis of the joint of the wounded thumb.

I know of the case of a well known veterinarian, who related to me the facts in person, who was inoculated in the hand while opening a tubercular cow, and who suffered from a tumefaction of the resulting cicatrix, which was excised and which showed tubercle bacilli on section.

To these cases may be added two others which have come under the observation of the writer recently. Dr. E., a veterinarian of Chester county, Pa., cut the knuckle of his forefinger while making a post-mortem examination on a tubercular cow. The wound healed badly, remained swollen, and showed decided tendency to ulcerate. Removal of the cicatrical mass was practiced and the tissues sent to me for examination. They showed typical tubercular lesions with giant-cell formation.

On January 1, 1900, my assistant, Mr. G., while performing a post-mortem on a goat which had succumbed to experimental inoculation with a culture of bovine tubercle bacillus, scratched his knuckle on the broken ends of the ribs. Within a half hour the wound was washed out with a 1:1000 solution of mecnric chlorid, and sealed. It healed promptly, but about 3 weeks after became reddened, swollen, and sensitive, especially on motion. It was protected but grew worse, and on February 27, Dr. C. H. Frazier excised the nodule, with a margin of healthy skin. With one-half of the nodule we inoculated two guinea pigs snb-cutaneously, and the other part was prepared for sections. These sections show an infiltration-process which en-

croaches on the papillary layer of the skin, some of the papillae being destroyed. No typical giant-cells can be made out. None of the sections were stained for tubercle bacilli. On May 5 one of the inoculated pigs died and the other was killed. Both of them showed a generalized tuberculosis involving the chest-cavity as well as the abdomen. There has been no return of the lesion so far.

Dr. M. B. Hartzell, of the University of Pennsylvania, has also observed two cases in which there was almost certainly accidental inoculation with the bovine tubercle bacillus. Both occurred in men who were employed by one of our large railway companies in the care of cattle cars. In both the disease appeared first in the skin of the hand, and followed slight injuries received from pieces of timber while working on the cars, the wounds healing without trouble at the time, but later showing changes characteristic of tuberculosis. In one case the local disease was soon cured and no further trouble resulted. The other, however, ended fatally after about a year through the disease becoming generalized, and the involvement of the lungs. This patient was a man of 44 years of age, weighing 175 pounds, in good health, and who had never had a serious illness. The hand healed entirely, and remained sound up to the time of his death.

Contagion from animals to men who are in attendance on them is to be feared principally in stables which are greatly affected and in which the amount of tuberculous matter spread around is large. The danger is greater for those who pass a great deal of their time in the stable, and in those stables which are badly kept, dark and poorly ventilated. Bigoteau has shown that in some villages of Beauce, where the families pass the whole winter season in the stable, tuberculosis is exceptionally frequent among them.

Contagion of animals by tubercular attendants.—It is also possible that under some circumstances, such as are rare in this country, tuberculosis may be transmitted to animals by tuberculous attendants. Bang has published the following instances of this: "A man worthy of belief told me that on a large farm where tuberculosis had never been seen, a phthisical servant was employed, who was in the habit of spitting in the forage. Little by little the majority of the cows on the place became tubercular and died." * * * "On another farm, where the disease had never been observed before, and where 25 cows were kept, tuberculosis broke out and showed great virulence for two or three years, following the arrival of a stableman who coughed and spit in the stable." * * * "A well kept piggery of 80 animals had always been free from disease up to 1885. During this year a phthisical attendant, who coughed and expectorated a great deal, was employed. He remained on the farm some time, until sent home in a dying condition. Soon after tuberculosis appeared among the pigs, and a large number were affected."

Cozette has given the following example of infection of cows by a tubercular attendant. In a well kept stable, containing 24 cows and one bull, all in good condition, tuberculosis had never been known. In 1886 two cows began to cough and were slaughtered, one being so badly tubercular that it had to be condemned. One after the other all the cows in this same row were attacked and were sent to the slaughter house, as soon as they became ill, but in 1892, the tuberculin test showed that of the 20 animals composing the herd, 7 were tubercular, these 7 being in the same row, the 12 in the other row being quite sound. The diagnosis was confirmed by post-mortem examination in all of these cases. Inquiry into the cause of the contamination of the stable revealed the fact that in 1883, three years before the recognition of the first two cases, the farmer had engaged as a herdsman, a man suffering from pulmonary tuberculosis. This man slept in the stable immediately over the two cows which were the first to fall ill, and was in the habit of coughing and expectorating constantly. He resided in the stable until 1891, in the meantime having been treated for pulmonary tuberculosis. In the absence of all other opportunities for contamination, and the fact that no strange cattle had been brought in, which might have introduced the disease, it seems impossible to avoid the conclusion that this stable was infected by the tubercular attendant; and especially in view of the experiments related on the foregoing pages of where animals have been rendered tubercular by the products of diseased men.

Tuberculosis is not a hereditary disease.—There is still one point bearing on the question of the transmission of tuberculosis from cattle to man which remains to be considered, namely, the influence of heredity. Until quite recently when the disease appeared in children and young persons it was believed to be hereditary, but careful study has shown that all the facts are against this idea, and it may be stated positively that inheritance plays a very small part in the spread of tuberculosis. It is, however, unquestionably true that the children of tuberculous parents are much more apt to become tuberculous than the children of healthy parents, a fact well shown by comparative statistics, and from this rather common observation has arisen the belief held until recently even by members of the medical profession, that the disease was commonly transmitted by inheritance. In these cases, however, we have only ideal conditions for contagion, the children being constantly and closely associated with their diseased parents, kissing them, sleeping in contact with them, and what has been shown experimentally to be especially dangerous, eating from the same plate of food and drinking from the same cup. I have already given some figures showing the frequency of intestinal

tuberculosis in children, using them as evidence of the transmission of tuberculosis by means of food. We will now see if there is any reason to admit that these cases may have been congenital. In 1889, Woodhead published a series of statistics of tuberculosis in children, showing that during the first year of life the number was comparatively small, but that from one to five and a half years there was a rapid rise, which could be accounted for only on the supposition that infective material found its way into the digestive tract of children, most probably along with milk, and produced there intestinal and mesenteric tuberculosis. If this is the correct idea as to the origin of the disease in children, we would expect that the death rate from tuberculosis would increase with age from birth, and for a certain period after, during the time when children are fed largely on a milk diet, and such seems to be the case.

Bolz, examining the statistics of children who died in Keil during the years 1873-1889, on whom post-mortem examinations were made, found that 16.4 per cent. of the whole mortality, or 424 out of 2,576, was due to tuberculosis, and he gives the percentages of tuberculosis to the whole mortality at each of the different ages, as follows:

	Per cent.
Still-born children,	0.0
Up to four weeks old,	0.0
From 5-10 weeks old,	0.9
From 3-5 months old,	8.8
From 6-12 months old,	18.3
From 1-2 years old,	26.8
From 2-3 years old,	33
From 3-4 years old,	29.6
From 4-5 years old,	31.8
From 5-10 years old,	34.3
From 10-15 years old,	30.1

Observations on the lower animals.—The number of calves slaughtered in abattoirs gives abundant opportunity for observation on this point also. Nocard gives the following figures: At the abattoir in Munich about 160,000 calves are killed each year. Of this number two only, in 1878, were found tubercular, one in 1879, none in 1880, none in 1881, and two in 1882. At Lyons, Leclerc, who has studied this question particularly, has found in some 400,000 calves that five only were tubercular. Jöhne, in Berlin, has found four in more than 150,000. From the 1st of April, 1892, until the 31st of March, 1893, there were killed in the public abattoirs of Prussia 600,501 grown animals, of which 51,136, or 8.6 per cent., were tubercu-

lar. During the same time 914,216 calves were also slaughtered; 446 or about 0.04 per cent., were tubercular.

Saxony is perhaps more gravely infected with tuberculosis than any other part of Europe. In 1890, in all of the abattoirs of the kingdom, 16.5 per cent. of the cattle were tubercular, while the proportion of calves which were tubercular was only 0.04.

To better understand the value of these figures, it must be remembered that cows are very much more subject to tuberculosis than are the males of the bovine species. At Copenhagen, in 1888, for cattle of all kinds and ages, the percentage of tubercular ones was 6 per cent., while for cows the proportion was 16 per cent. In European countries of all calves slaughtered under one month old, not more than one in 10,000 is tubercular.

There is, however, no doubt that hereditary transmission of tuberculosis does take place at times, but so seldom that it may be almost ignored as a factor in the spread of the disease. There are now 20 cases of congenital tuberculosis of infants on record; and an even larger number has been observed among the lower animals. The following table taken from Nocard and Leclainche (with a few additions) gives a partial list of such cases. Professor Bang in eight years has gathered reports of 85 cases of congenital tuberculosis, partly in fetuses and partly in new born calves. When we consider the enormous number of observations which have been made, this small number of reports of cases proves that hereditary transmission is extremely rare.

Bacilli Found.			Bacilli Not Found.		
Observer.	Subject.	Age.	Observer.	Subject.	Age.
Johne, ...	Fetus, ...	8 mos.	Grothaus, ...	Fetus, ...	9 mos.
Malvoz et Brouwier, ...	Fetus, ...	8 mos.	Kohler, ...	Fetus, ...	?
Czokor, ...	Fetus, ...	?	Misselwitz, ...	2 fetus, ...	?
McFadyean, ...	Calf, ...	5 days.	Falk, ...	Calf, ...	5 days.
Bang, ...	Fetus, ...	6 mos.	Bayersdorfer, ...	Calf, ...	14 days.
Bang, ...	Calf, ...	Born dead.	Lucas, ...	Fetus, ...	6 mos.
Bang, ...	2 calves, ...	1 day.	Kohl, ...	Calf.	2 days.
Bang, ...	2 calves, ...	2 days.	Sahner, ...	Calf, ...	8 days.
Bang, ...	1 calf, ...	14 days.	Barlund, ...	2 calves, ...	7 days.
Ruser, ...	2 calves, ...	1 day.	Beckers, ...	1 calf, ...	14 days.
Siegen, ...	6 fetus, ...	6-8 mos.			
Siegen, ...	32 calves, ..	14 days.			
Lungwitz, ...	Fetus, ...	6 mos.			
Lungwitz, ...	Fetus, ...	4½ mos.			
McFadyean, ...	Calf, ...	Few days.			
McFadyean, ...	Calf, ...	7 days.			
Ravenel, ...	Fetus, ...	7 mos.			

Danish system.—Perhaps the strongest argument against the occurrence of hereditary transmission of tuberculosis, and one which of itself seems to be convincing, lies in the well proven fact that it is possible in the vast majority of cases, to rear healthy animals from tuberculous parents, provided they are removed at once and fed on sterilized milk, which may, however, be taken from tuberculous cows. This is the practice in the Danish system, described in another part of this report (see page 247). On one farm where Bang has carried out this system for three years, there were 131 tubercular animals against only 77 healthy ones, yet during this time all of the calves born of the diseased cows were raised in perfect health, with the exception of two only.

Orphan asylums.—The statistics of orphanages show the same thing, though not in quite so positive a manner. Thus Stich, physician to the Orphan Asylum in Nuremberg, during eight years has seen only one case of tuberculosis among the hundred children living there, though many of them came from tuberculous ancestors. In Munich, Schnitzlein, physician to the Orphanage, from 1866 to 1888, saw 613 children, of whom 43.59 per cent. had lost either father or mother by tuberculosis, and 6.86 per cent. had lost both parents of this disease, yet since 1876 not a single death has taken place in the institution from tuberculosis. These figures are very striking when compared with tables showing the usual death rate from tuberculosis at the same age, and demonstrates clearly that tuberculosis is in the vast majority of cases the result of infection after birth.

CHAPTER IV.

THE DISPOSITION OF THE FLESH OF TUBERCULAR CATTLE.

SUMMARY.

TUBERCLE BACILLI SOMETIMES INVADE THE BLOOD AND THE PARTS OF THE ANIMAL THAT ARE EATEN. IN THESE CASES, THE FLESH IS CAPABLE OF PRODUCING TUBERCULOSIS UNLESS IT IS SO WELL COOKED THAT ALL OF THE TUBERCLE BACILLI ARE KILLED.

IN MOST CASES, HOWEVER, THE DISEASE IS LOCAL AND ITS GERMS ARE CONFINED TO THE SYSTEMS OF ORGANS SOME PARTS OF WHICH SHOW TO THE NAKED EYE EVIDENCE OF DISEASE.

TUBERCULAR CATTLE SHOULD BE VERY CAREFULLY EXAMINED AT THE TIME OF SLAUGHTER AND THE DISPOSITION OF THE FLESH SHOULD DEPEND UPON THE CHARACTER AND EXTENT OF THE LESIONS THAT ARE FOUND.

The flesh may contain Tubercle Bacilli.—Ever since it has been shown by Villemin that tuberculosis can be transmitted by feeding tuberculous material, and since Koch has shown the identity of human and animal tuberculosis, it has been apparent that danger must attend the unrestricted use of food of the flesh of tubercular animals. Chauveau, Arlong, Galtier, Nocard, Bollinger, McFadyean, Woodhead and Martin have worked on this problem and as a result of their investigations, and others as well, it is clear that the ingestion of tuberculous material will produce tuberculosis in a high percentage of cases. Leclainche has shown that out of 566 inoculations with the juice expressed from the meat of tubercular cattle, 17.3 per cent. gave positive results. Comparatively few experiments have resulted affirmatively where similar material was fed to experimental animals. The explanation of this lies, no doubt, in the fact that more tubercle bacilli are required to produce infection by way of the digestive tract than when injected into the peritoneal cavity or underneath the skin. The feeding experiments in which meat from tubercular animals was used and not tubercular lesions, have shown that the disease must be generalized before the meat becomes infectious.

How Tuberculosis spreads in the body.—By reverting to the pathology of tuberculosis, it will be noted that the disease always begins as a local process and that the bacilli are, for a time, confined absolutely to the point where they lodge and grow. From this point the germs of the disease may spread (1) through the lymphatic channels, (2) through contiguous tissues or cavities, or (3) they may be carried in the blood.

It is well known that tuberculosis usually starts in some part of the respiratory or digestive tract. The point of origin can sometimes be determined by the age of the lesion; but if the lesions are extensive and widespread, the differences between them are not distinct enough to enable one, in all cases, to determine the original point of infection. If, however, the lesions are found in one organ and in the lymphatic gland connected with it, as in the lungs and mediastinal or bronchial glands, and no lesions are to be found in other parts of the body, it is probable that the tubercle bacilli entered the lungs, passed through the mucous membrane lining the air passages, probably producing a tubercle at the point of passage, and their progeny were then carried through the lymphatic channels to the glands. The lymphatic glands act as filters and remove solid matter from lymph; so here the germs are detained and grow. If the only tubercular lesions are found in the lymphatic glands of the mesentery it is evident that infection occurred through the walls of the intestinal canal.

Tubercle bacilli may emerge from diseased lungs or lymphatic glands adjacent to them, and enter the pleural cavity. In this cavity they are distributed over a large surface. It is conceivable that they are well rubbed into the pleura by the movements of the lungs and thus the tubercular lesions of the pleura result. From this cavity, or if—by a process similar to that just described—a tubercular peritonitis is established, tubercle bacilli may pass through the diaphragm and infect the adjacent cavity.

If lesions are found in the substance of the spleen, in the kidneys or in the bones, it is evident that tubercle bacilli were carried by the blood because they could reach these parts in no other way. This is also manifest when many small tubercles of uniform size are distributed widely through both lungs. Where there is evidence of such generalization, the meat is particularly dangerous. This condition arises when the wall of a blood vessel is involved in the tubercular process, disintegrates and admits tuberculous material into the circulation. The flesh of an animal cannot be involved in a tubercular process excepting when tubercle bacilli are carried into it by the blood or grow into it from neighboring lesions.

Tubercle Bacilli do not remain long in the blood.—It was once supposed that tubercle bacilli admitted to the blood circulated in it indefinitely. It has, however, been shown by Nocard that even when

tubercle bacilli are injected into the blood in large numbers, they are deposited in the solid tissues or they are destroyed within four or five days. Hence, in any animal the blood is not infectious for a long time.

An animal may be dangerous to its herd mates and still have sound flesh.—An animal may have a softened tubercular area in the lungs from which tubercular debris is constantly being eliminated and expectorated. Such an animal is dangerous to its herd mates. Moreover, the tubercle bacilli that it excretes through the respiratory tract, may readily lodge in places where they may afterwards fall into the milk as it is drawn from the cow and propagate disease in this way. If, upon slaughtering this animal, it is found that the lesion in the lungs is local, that is to say, if it does not extend beyond these organs and the lymphatic glands attached to them, there is no reason to fear that the meat is at all infectious. If, on the contrary, it should be found that in addition to the lesions in the lungs and lymphatic glands attached to them there were caseous, tuberculous areas in the liver or kidneys, this would indicate that the tubercle bacilli had been carried by the blood. In the latter case there was a chance for the flesh to become infected, so the meat should not be used.

If the lymphatic glands in the fleshy part of the carcass show tubercular changes, or if the pleura lining the ribs is studded with tubercular growths there is a probability that the meat is infected.

The distribution of lesions shows how Tubercle Bacilli were carried.—By examining the lungs of a tubercular animal it is often possible to determine whether tubercle bacilli have entered and been carried by the blood. If the tubercles in the lungs are all adjacent to the air passages, it is evident that the bacilli have been carried in these passages; but if they are away from the air passages and in the walls of and adjacent to the blood vessels it is then evident that they have been carried by the blood. Indeed tubercles in the walls of and immediately adjacent to the blood vessels of the lungs are among the most common lesions resulting from blood-borne tubercle bacilli. The reason for this is plain. The tubercle bacilli that enter in any part of the body are carried to the left heart and thence pumped through the pulmonary artery to the lungs. In the lungs the blood passes through an intricate net work of fine capillaries, where there are excellent opportunities for many of the tubercle bacilli to be detained and to lodge upon their walls. And wherever tubercle bacilli lodge and grow, tubercles are produced.

When the flesh of tubercular animals is not dangerous.—It must now be evident that the flesh of all tubercular animals cannot be regarded as equally dangerous, for where the disease is purely local and there is no evidence that the tubercle bacilli have been

carried to the flesh or through the blood, there is no reason to believe that the meat contains tubercle bacilli and, this being the case, it cannot produce tuberculosis.

Local meat inspectors regard all carcasses of tubercular animals alike. —The meat inspectors of Philadelphia and of other places in Pennsylvania where meat inspectors are employed, do not discriminate between tubercular carcasses. They go on the principle that all meat from tubercular cattle is dangerous and all of it must be condemned.

Federal meat inspectors discriminate.—In the federal meat inspection service carried out by the Bureau of Animal Industry, it is provided that only advanced or generalized cases of tuberculosis shall be condemned. In slight and local tuberculosis, only the diseased parts are condemned and the remaining healthy portions of the carcass are used for food.

The system that is in vogue among the local inspectors in this State would not be possible if our cattle were afflicted with tuberculosis to the extent that they are in Europe. Since meat inspectors come upon tubercular animals only occasionally, their condemnation does not cause very great loss. If, however, 10 to 40 per cent. of all cattle killed for food were tubercular, as is the case in Germany, the losses under the present system would be unbearable and a change would speedily occur.

Opinion of the international veterinary congress.—At the International Veterinary Congress held in Baden Baden in 1899 it was resolved that there is need for a general inspection of food animals both before and after slaughter. It was recommended in regard to tubercular animals that all parts of the body actually afflicted with tuberculosis should be destroyed, together with the lymphatic glands adjacent or attached thereto, and that when there is evidence of blood infection or recent generalization, the entire carcass should be condemned. Where the lesions are local or where there is an old but stationary generalization of the lesions confined to the viscera, the meat is considered safe for general consumption. Where the lymphatic glands in the muscular tissue are tubercular or where the local character of the disease and the harmlessness of the meat are in doubt, it is recommended that it should be sterilized by thorough cooking and sold only in this condition.

Ostertag's method.—The method recommended by Ostertag may be a useful one where, as in Germany, there are facilities for sterilizing the flesh of some tubercular animals, which are then sold as cooked meat, and where the flesh of animals in other stages of disease can be sold from a special stall with a caution that it may be harmful if not thoroughly cooked. Ostertag's method is as follows:

1. The flesh of animals with slight or restricted lesions of tuber-

culosis, in which the disease is purely local, may be sold without restriction after the tubercular parts are removed.

2. The flesh of animals with more extensive, but unquestionably local lesions may be sold raw, with a caution to the purchaser.

3. When there are lesions of a generalized tuberculosis confined to the organs (lungs, liver, spleen or kidneys), and these lesions have healed, the flesh may be sold without restriction or with a caution to the purchaser, according to the development of the disease

4. The flesh must be excluded from consumption and used for technical purposes only when the animal is emaciated, or when there is evidence of recent infection of the blood (as shown by enlarged spleen, swelling of the lymphatic glands, miliary tubercles in the lungs, liver, spleen or kidneys) or when the flesh contains lesions of tuberculosis.

5. When there is doubt as to the local character of the disease and the harmlessness of the flesh, the meat should be cut into small pieces and thoroughly cooked or, better, sterilized with steam, and it may then be placed on the market.

Prussian regulations.—The official regulations of Prussia, adopted March 26, 1892, provide in regard to the disposition of the flesh of tubercular animals:

"A. The flesh of a tubercular animal is to be considered unwholesome when tubercles are found in the flesh or if the tubercular animal is emaciated even if it does not contain tubercles in the flesh.

"B. On the other hand, the flesh of a tubercular animal is to be considered safe (1) when the lesions are confined entirely to one organ, or (2) in case two or more organs are affected; these organs shall be in the same body cavity and connected with each other directly or through the lymphatic channels or by blood vessels that are not a part of the general circulatory system but belong to the portal or to the pulmonary circulation."

Bavarian regulations.—In Bavaria, the regulation that has been in operation since June 20th, 1892, governing the meat of tubercular cattle and swine, is as follows:

"A. If, in slaughtered cattle or swine, it is found that tuberculosis is localized and in the first stages of its development and if the animal is in a well nourished condition, the flesh is to be permitted to go on to the market after the diseased organs have been removed and destroyed.

"B. The flesh of animals and swine that are afflicted with general or advanced tuberculosis and that at the same time are emaciated, and meat that contains tubercular lesions is to be looked upon as unwholesome and is to be excluded from human consumption."

Saxon regulations.—The regulations of Saxony, established May, 1887, provide:

"The flesh of tubercular animals is to be considered unwholesome when the disease is generalized (not confined to one organ and the lymphatic glands proper to it) or widespread (not confined to small areas), that is to say, when, in addition to tuberculosis of the organs of the thoracic cavity, there is at the same time tuberculosis of the organs of the abdominal cavity or advanced tuberculosis of the peritoneum, or when in addition to tubercular changes in the organs of the thoracic cavity, or the pleura, or the organs of the abdominal cavity, or the peritoneum, there is tuberculosis of the lymphatic glands of the body, of the muscles, of the bones or of the udder, or when in addition to extensive tuberculosis of the organs, the animal is also emaciated."

Recommendations of the Royal Commission.—In Great Britain this question of meat inspection was considered by the Royal Commission on Tuberculosis which reported in 1898. Their recommendations are as follows:

"MEAT.

"A. Slaughter Houses.

"1. We recommend that in all towns and municipal boroughs in England and Wales and in Ireland, powers be conferred on the authorities similar to those conferred on Scottish corporations and municipalities by the Burgh Police (Scotland) Act, 1892, viz:

"(a) When the local authority in any town or urban district in England and Wales and Ireland has provided a public slaughter house, power be conferred on them to declare that no other place within the town or borough shall be used for slaughtering, except that a period of three years shall be allowed to the owners of existing registered private slaughter houses to apply their premises to other purposes. The term three years to date, in those places where adequate public slaughter houses already exist, from the public announcement by the local authority that the use of such public slaughter houses is obligatory, or in those places where public slaughter houses have not been erected, from the public announcement by the local authority that tenders for their erection have been accepted.

"(b) That local authorities be empowered to require all meat slaughtered elsewhere than in public slaughter house, and brought into the district for sale, to be taken to a place or places where such meat may be inspected; and that local authorities be empowered to make a charge to cover the reasonable expenses attendant on such inspection.

"(c) That when a public slaughter house has been established, inspectors shall be engaged to inspect all animals immediately after slaughter, and stamp the joints of all carcasses passed as sound.

"2. It appears desirable that in London the provision of public

in substitution for private slaughter houses should be considered in respect to the needs of London as a whole and in determining their positions, regard must be had for the convenient conveyance of animals by railway from the markets beyond the limits of London, as well as from the Islington market, to the public slaughter houses which should be provided. At the present time no administrative authority has statutory power authorizing it to provide public slaughter houses other than for the slaughter of foreign cattle at the port of debarkation.

"3. With regard to slaughter houses in rural districts, the case is not so easy to deal with. But the difficulty is one that must be faced, otherwise there will be a dangerous tendency to send unwholesome animals to be slaughtered and sold in small villages where they will escape inspection. We recommend, therefore, that in Great Britain the inspection of meat in rural districts be administered by the county council. In Ireland the duty of carrying out inspection ought to devolve upon authorities corresponding as nearly as possible to those charged with that duty in England and Scotland. In view of the announced intention of the government to introduce a new scheme of local government into Ireland we refrain from specifying the exact machinery which should be employed.

"4. We further recommend that it shall not be lawful to offer for sale the meat of any animal which has not been killed in a duly licensed slaughter house.

"B. Qualifications of Meat Inspectors.

"5. We recommend that in future no person be permitted to act as a meat inspector until he has passed a qualifying examination before such authority as may be prescribed by the local Government Board (or Board of Agriculture), on the following subjects:

"(a) The law of meat inspection, and such by-laws, regulations, etc., as may be in force at the time he presents himself for examination.

"(b) The names and situations of the organs of the body.

"(c) Signs of health and disease in animals destined for food, both when alive and after slaughter.

"(d) The appearance and character of fresh meat, organs, fat, and blood, and the conditions rendering them, or preparations from them, fit or unfit for human food.

"C. Tuberculosis in Animals Intended for Food.

"6. We recommend that the Local Government Board be empowered to issue instructions from time to time for the guidance of meat inspectors, prescribing the degree of tubercular disease which, in

the opinion of the Board, should cause a carcass, or part thereof to be seized.

"Pending the issue of such instructions we are of the opinion that the following principles should be observed in the inspection of tuberculous carcasses of cattle:

The entire carcass and all the organs may be seized.	"(a) When there is miliary tuberculosis of both lungs. "(b) When tuberculous lesions are present on the pleura and peritoneum. "(c) When tuberculous lesions are present in the muscular system, or in the lymphatic glands embedded in or between the muscles. (d) When tuberculous lesions exist in any part of an emaciated carcass.
The carcass, if otherwise healthy, shall not be condemned, but every part of it containing tuberculous lesions shall be seized.	"(a) When the lesions are confined to the lungs and thoracic lymphatic glands. "(b) When the lesions are confined to the liver. "(c) When the lesions are confined to pharyngeal lymphatic glands. "(d) When the lesions are confined to any combination of the foregoing, but are collectively small in extent.

"In view of the greater tendency to generalization of tuberculosis in the pig, we consider that the presence of tubercular deposit in any degree should involve seizure of the whole carcass and of the organs.

"In respect to foreign dead meat, seizure shall ensue in every case where the pleura have been 'stripped.'"

British regulations.—The latest order issued in Great Britain covering the treatment of tubercular animals bears date of March 11, 1899. It is based upon the above recommendations and provides that the entire carcass and all of the organs shall be seized:

(a) When there is miliary tuberculosis of both lungs.

(b) When there are tuberculous lesions on the pleura and peritoneum.

(c) When tuberculous lesions are present in the muscular system or in the lymphatic glands imbedded in or between the muscles.

(d) When tuberculous lesions exist in any part of an emaciated carcass.

The carcass if otherwise healthy should not be condemned but every part of it containing tuberculous lesions shall be seized:

(a) When the lesions are confined to the lungs and the thoracic lymphatic glands.

(b) When the lesions are confined to the liver.

(c) When the lesions are confined to the pharyngeal lymphatic glands.

(d) When the lesions are confined to any combination of the foregoing but are collectively small in extent.

Lack of general regulations or uniform practice in Pennsylvania.—Since no regulations have ever been formulated to govern the disposition of the flesh of tubercular animals in Pennsylvania in the localities where meat inspection is practiced, other than to destroy outright the carcasses of all animals tubercular in any degree, it has not been possible for the State Live Stock Sanitary Board to arrange for the utilization of the carcasses of any of the animals condemned under its auspices. If, in the future, a more carefully studied out plan for dealing with such carcasses shall be devised and put in operation by the local authorities, it will be possible to effect a very material saving to the State by utilization of such carcasses as show only slight and local alterations, and to suppress tuberculosis among herds at a more rapid rate without increased expense. The effect of such an arrangement would be to greatly safeguard the public health. There is reason to believe that at present, animals that are thought to be tubercular and that are designed for slaughter, are killed in slaughter houses in the outskirts of towns and cities where there is no inspection and their carcasses are placed on the market without restriction. Some of these animals are, no doubt, afflicted with tuberculosis to a very advanced degree; while animals diseased to a very much less degree are condemned and their carcasses seized if detected in the city. If the inspection were discriminative and only such meat as is dangerous to health were condemned and slight local cases of tuberculosis were dealt with as they are with perfect safety in other places where this question has been studied carefully for a long time, the surreptitious killing of tubercular animals in small slaughter houses could more readily be discouraged and this source of danger to the public removed. The method at present in operation consists, in effect, in closing the eyes to the dangers of tubercular animals slaughtered outside of the city or town having inspection and admitting such meat freely; while even the slightest cases, which there is no reason to believe are dangerous, are seized if slaughtered within the city or town limits.

CHAPTER V.

MORBID ANATOMY.

SUMMARY.

THE MOST USUAL SEAT OF TUBERCULOSIS IS THE LUNGS, GIVING WHAT IS KNOWN COMMONLY AS PHTHISIS OR CONSUMPTION.

THE DISTINCTIVE LESION OF TUBERCULOSIS IS THE TUBERCLE, FROM WHICH THE DISEASE DERIVES ITS NAME. TUBERCLES ARE AT FIRST VERY MINUTE, BUT MAY ATTAIN CONSIDERABLE SIZE BY MASSING TOGETHER. IN MAN, CAVITY FORMATION IN THE LUNGS IS MUCH MORE COMMON THAN IN CATTLE. THE DISCHARGES FROM THESE CAVITIES ARE COUGHED UP AS SPUTUM, VERY RICH IN BACILLI, CONSTITUTING ONE OF THE CHIEF METHODS BY WHICH THE DISEASE IS SPREAD.

COWS ALSO COUGH UP MATERIAL CONTAINING TUBERCLE BACILLI, BUT TO A LESS EXTENT.

A COMMON TYPE OF TUBERCULOSIS IN CATTLE IS THE FORMATION OF FLESHY TUMORS OR NODULES ON THE SEROUS SURFACES OF THE LARGE CAVITIES OF THE BODY, GIVING WHAT IS KNOWN AS "PEARLY" OR "GRAPE" DISEASE.

THERE IS NO ORGAN OR PART OF THE BODY, EITHER IN MAN OR ANIMALS WHICH IS EXEMPT FROM ATTACK.

Human Tuberculosis.—In man tuberculosis shows itself most frequently by affecting the lungs, producing the disease known as phthisis or consumption, though there is no part of the body which may not be affected. In one thousand autopsies there were 275 cases with tuberculous lesions. With but two or three exceptions the lungs were affected. The distribution in the other organs was as follows:

Pericardium,	7
Peritoneum,	36
Brain,	31
Spleen,	23
Liver,	12
Kidneys,	32
Intestines,	35
Heart,	4
Generative organs,	8

In chronic tuberculosis of the lungs a large variety of lesions may be noticed, such as nodular tubercles which often attain a considerable size, diffuse tuberculous infiltration, areas which have undergone caseous degeneration, pneumonic areas, cavities of various sizes and also changes in the pleura, bronchi and bronchial glands. The most advanced lesions are commonly found in the apices, the disease progressing downwards, usually more rapidly in one lung than in the other. During cavity formation through the softening and breaking down of nodules, small vessels are ruptured and hemorrhage takes place. Large quantities of purulent matter may also be thrown out through the mouth. These products of the breaking down of tubercle are very rich in tubercle bacilli and constitute the chief mode in which a tuberculous person is dangerous to his fellow men. Nuttall has estimated by his method of counting that in a patient in whom the disease was moderately well advanced and where expectoration amounted to from 70 to 130 cc. per day, the number of bacilli daily expectorated amounted to from one and a half to four and one-third billions in number. These figures emphasize the precautions which we should take in the disinfection of sputum from tuberculous patients. The interior of cavities in the lungs is often thickly lined with bacilli and they may be present in considerable numbers in the caseous matter.

Formation of the Tubercle.—The formation of a tubercle is comparatively simple. When the bacilli gain entrance to an organ, the fixed connective tissue cells, as well as those of the endothelium of the capillaries begin to multiply around them with the production of rounded, cuboidal or polygonal bodies with vesicular nuclei which stain clearly, and are known as epithelioid cells. Soon smaller round cells with a smaller amount of bioplasm, known as lymphoid cells infiltrate the tissue and the epithelioid cells are, as it were, hidden from view. From these appearances, the primitive tubercle is known as the epithelioid tubercle, and later when the lymphoid cells become predominant it is known as the lymphoid tubercle. All the new cells are normal but in an abnormal position.

The bacilli multiply and invade new tissue so that the tubercle spreads from the periphery. When it reaches the size of a pin's head the lymphoid cells have usually become so numerous as to interfere with nutrition, and degeneration begins to take place, starting at the centre. The most delicate cells, which are usually the lymphoid, die first, the epithelioid cells resisting for a longer time. The centre breaks down into a sort of granular matter and the contained bacilli usually perish also, or at least disappear. This death of the cells is known as coagulation necrosis or caseation. These processes may be rapid or slow. When rapid all the cells die, leaving a slightly yellowish granular matter. When slow the cells seem to fuse to-

gether, as it were, to form giant cells. These giant cells are most often, probably, the product of a fusion of the epithelioid cells though they seem also to be formed by an increase in the protoplasm and a multiplication of the nuclei in an individual cell. The formation of giant cells seems to be in inverse ratio to the number and virulence of the bacilli. In tuberculosis of the joints and skin and in scrofulous glands where the bacilli are scanty, giant cells are found in large numbers, while in miliary tubercles and in other lesions where the bacilli are in large numbers, giant cells are not so often met with.

Giant cells were at one time considered diagnostic of tubercle but this is now known not to be the case. The arrangement of the nuclei in a wreathlike form around the periphery or else at the poles, is however, peculiar to tuberculosis. Tubercles undergo two forms of degeneration—caseation and sclerosis. Caseation is a destructive and dangerous process, while sclerosis may be regarded as a healing process. It is believed by many to be due to the poisonous action of the bacilli or their products. It begins at the centre, as described above, and proceeds outward, the cells losing their outline and their property of taking up stains, and are finally converted into a homogenous, structureless substance in which the bacilli are abundant. No blood vessels are found in them. When massed together these form the cheesy nodules found in tuberculosis, and may undergo softening and encapsulation or calcification.

In the second process of degeneration there is a great increase in the fibroid elements, the tubercle becoming converted into a firm, hard structure. In the peritoneum this seems to be the natural tendency of the tubercle, though it is found in the lung quite frequently. The final end of the tubercle depends upon the power of the individual to restrict or limit the growth of the bacilli.

Bovine Tuberculosis.—In bovine tuberculosis the anatomical changes are to be seen most frequently in the lungs and in the serous membranes of the large cavities of the body, where the nodules may be crowded together in great numbers so that the name "grape disease" has been given to this condition. In about half of all cases the lungs and serous membranes are simultaneously affected; the lungs alone in about one-third and the serous membranes alone in about one-fifth. The respective lymph glands always become affected also. When the disease becomes generalized almost every organ and tissue of the body may show changes. In the lungs we may find circumscribed pneumonic foci of different sizes which develop from a catarrhal pneumonia with imperfect expansion of the alveoli and the bronchioles, migration of leucocytes and accumulation of the large epithelioid cells in the interior of the alveoli, and subsequent caseation or suppuration of the affected areas, which

gives rise to the formation of cavities containing yellowish caseous, crumbling, and greasy or purulent material. These changes are accompanied by a chronic inflammatory process in the interstitial tissues of the lungs, giving rise to induration and thickening. They are seen mostly in the neighborhood of the tubercular foci, and show themselves by an interstitial new growth of connective tissue, and shrinking of the lung tissue, which sometimes shows an almost cartilaginous thickening, or even complete calcification which offers considerable resistance to the knife in cutting. Another condition seen in the lungs is characterized by the presence of miliary tubercles varying in size from a millet seed to the head of a pin, and being of a pale yellow color, moderately firm consistence and slightly translucent. They usually occur in great numbers and may be on the pleural surface of the lung or seen on the surface of sections, and at first are usually surrounded by healthy lung tissue. They later become caseated and calcareous, the process beginning at the centre. Large tubercular nodules are frequently made up by the agglomeration of a number of these miliary tubercles.

The bronchial mucous membrane is often in a condition of chronic catarrh in which greater or less dilation of the bronchi is not uncommon. Tubercular ulcers and miliary tubercles are not uncommonly seen in the mucous membrane of the bronchi and larynx. These ulcerations have thickened turned up edges, and the tubercles are arranged in rows. From the bronchial mucous membrane the tubercles spread into the adjacent tissues and also into the lung tissue. The bronchial glands are always found swollen, enlarged and infiltrated with miliary tubercles, and later are prone to become caseous and calcareous.

Grape disease.—The pleurae usually undergo a chronic inflammation which may be followed by adhesion to the lungs and the thoracic wall. Tuberculosis of the pleurae and peritoneum, called in Germany, perlsucht, and in English, grape disease, begins by the formation of minute light grey translucent nodules, which are smaller than a grain of sand, and which cause a granulated condition of the surface of these serous membranes. An abundant new growth of connective tissue takes place around these tubercles, so that they are, as it were, embodied in a frame-work of connective tissue. Through the confluence of several such tubercles, with the proliferation of the connective tissue, layers of nodules from the size of a lentil to a pea, form both on the visceral and the parietal membrane and may become as large as a hen's egg, or even the closed fist. When young they are of a rather soft, gelatinous consistence, have an orange color, showing on section a dark red centre, but later they grow harder and finally become fibrous in consistency, the surface becoming uneven and nodular, and grate on being cut through with

the knife. They may, on the other hand, undergo caseation or calcification of their central portion with the production of a brittle, mortar-like, greasy, yellow substance. In this condition their color is light grey or blueish white. They become variously grouped together so that they may present a villous, wart-like form, in appearance like a bunch of grapes, or they may take the shape of a cauliflower or mulberry. They may have a broad base or else be pedunculated. They may cover the entire surface of the serous membrane and increase in numbers to an enormous extent, so much so that the new tissue attains a weight of from sixty to eighty pounds or even more.

Glandular changes.—The anterior and posterior mediastinal glands become enlarged also. They may be infiltrated with miliary tubercles, indurated or caseous, and changed into tumors of considerable size, some of them being as large as 18 inches long. These tumors may enclose and compress the esophagus. Almost all of the lymph glands of the body may undergo changes similar to the above. On the head the glands usually affected are those of the larynx and parotid region; on the neck the retro-pharyngeal, middle and lower cervical glands; in the anterior extremities the glands of the shoulder, the axilla and brachial glands; in the posterior limbs the inguinal glands, the iliac glands and popliteal gland; on the udder the pudic or supra-mammary glands; on the croup the external pelvic glands; in the thoracic cavity, the intercostal and sternal lymph glands; in the abdominal cavity the glands of the mesentery, lumbar region, liver, spleen, kidneys, and so forth.

Abdominal cavity.—In the abdominal cavity besides the implication of the peritoneum and lymph glands there may be tubercular changes in the liver and spleen and other organs which will then contain large and small tubercles and caseous foci. The kidneys may become affected, enlarged and studded with numerous yellowish-white tubercles varying in size from a millet seed up to a pea. These nodules undergo a caseous change, beginning at their centres and become surrounded by a capsule of connective tissue. According to Schütz their development takes place in the interstitial tissue, during which process the normal component parts of the kidneys become destroyed, and at the same time a parenchymatous or hemorrhagic nephritis may be set up. The ovaries often become the size of a man's head. Tuberculous ulceration of the udder may be observed. Ulceration of the mucous membrane of the uterus occurs, the nodules being formed usually in the subserous inter-muscular or submucous connective tissue, and then ulcerating through into the uterine cavity. Tubercular disease of almost every part of the genital apparatus also occurs. The mucous membrane of the intes-

tine, especially in the colon, sometimes shows the tuberculous ulcerations, and less frequently in the abomasum or omasum.

Udder.—Tuberculosis of the udder, in cases of chronic general tuberculosis, manifests itself as a diffuse, firm enlargement, and, on post-mortem examination the gland lobules appear swollen, uniformly gray colored, and studded with small yellow points and striations, and show small hemorrhages. The larger milk ducts contain yellowish caseous masses with large numbers of bacilli. In older cases there occurs a considerable increase of the connective tissue of the udder, and firm tubercular nodules, which may be caseated or calcareous, are observed. The udder sometimes attains a tremendous size, has a nodular, firm feel, sometimes almost as hard as wood, and occasionally weighs as much as 40 pounds. In the walls of the milk reservoirs and the larger milk canals, large numbers of miliary tubercles may be present. All through the udder enormous deposits of tubercle bacilli may be found. The lymph glands lying above the posterior region of the udder always become enlarged and may become caseous. But these extensive changes in the udder do not occur until very late in the disease and are rare. The udder may be slightly tubercular and secrete excessively virulent milk without being more than nodulated.

Tubercular changes are met with not infrequently in the brain and spinal cord. Tubercles varying in color from gray to yellow, and from the size of a millet seed up to that of a hen's egg, may form in the pia mater, arachnoid, brain substance, and inner walls of the ventricles. They are most commonly found in the pia mater at the base of the brain and may remain there for a considerable length of time without producing inflammatory changes, though they may give rise to a tubercular meningitis so that the membranes of the brain may become adherent to each other. Similar changes are seen in the spinal cord, in which the pia and dura mater become filled with numerous small tubercles and frequently become adherent to each other.

Tubercular changes are also met with in the eye, in the iris and choroid. In the muscular system, especially the muscles of the croup, adbomen, chest and heart with adhesions of the heart to the pericardium, in the bones, in which it usually starts from the medulla and runs its course by the formation of reddish gray granular foci, with breaking down of the bone tissue with central caseation and the formations of cavities. Tubercular changes also occur in the cartilages, such as the septum of the nose; in the joints; in the large blood vessels; and in the skin.

Statistics.—The researches made from 1888 to 1889 in the German empire, respecting the seat of tubercular changes, show the following results: One organ only was affected in from 50 to 60 per cent.

of the cases; one cavity of the body, in 13 to 17; several cavities, in 15 to 20; and the flesh in about one-half per cent. General tuberculosis was present in 10 per cent. The following table* gives the comparative frequency of the disease in different organs:

	Per cent.
Lungs,	75
Visceral pleurae,	55
Peritoneum,	48
Costal pleurae,	47
Bronchial and mediastinal glands,	29
Liver,	28
Spleen,	19
Uterus,	10
Lumbar glands,	5
Pharyngeal glands,	4
Trachea,	3
Udder,	1
Intestines,	1
Ovaries,	1
Lymph glands of the liver,	1
Lymph glands of the thoracic and abdominal cavities,	0.9
Heart,	0.9
Kidneys,	0.7
Bones,	0.4
Internal viscera (including the brain),	0.3
All the organs of the thoracic and abdominal cavities,	2.0
Submaxillary glands,	0.2
Diaphragm,	0.2
Stomach,	0.16
Larynx,	0.13
Muscles,	0.1
Iliac and inguinal glands,	0.06
Brain,	0.04
Spinal cord,	0.03
Tongue,	0.01
Thymus gland,	0.01
Vagina,	0.01
Testicles,	0.01

These figures differ somewhat from those given in the two following tables which are taken from American sources. The first gives the result of 1,200 post-mortem examinations made under the direc-

*This table is made up from slaughter house records of animals killed in Germany and covers animals of both sexes and all ages. For this reason, figures relating to sexual organs, as the udder, are of little value, as it is not known how many milch cows are reported upon.

tion of Dr. Pearson for the State Live Stock Sanitary Board of Pennsylvania. The organs mentioned are arranged in the order of frequency of infection. The actual number of lesions in a given organ are indicated in the first column and the percentage is shown in the second. Practically all of the animals covered by this table were milch cows.

TABLE SHOWING DISTRIBUTION OF LESIONS IN 1,200 CASES OF TUBERCULOSIS.

Structures Presenting Lesions on Autopsy, Arranged in Order of Frequency of Infection.	Number of cases in which infected.	Number per cent. infected.
Right lung,	724	63.1
Mediastinal lymphatic glands,	725	60.7
Left lung,	685	57.3
Bronchial lymphatic glands,	404	33.8
Small intestine,	388	32.5
Mesenteric lymphatic glands,	278	23.25
Pleura,	264	22.0
Liver,	247	20.7
Large intestine,	189	15.8
Post pharyngeal lymphatic glands,	181	15.15
Peritoneum,	168	14.0
Lymphatic glands of udder,	161	13.5
Diaphragm,	136	11.4
Portal lymphatic glands,	123	10.3
Lymphatic glands of flank,	108	9.0
Udder,	104	8.75
Pericardium,	98	8.2
Lymphatic gands of shoulder,	93	7.75
Stomach,	86	7.2
Spleen,	68	5.7
Uterus,	66	5.5
Kidneys,	25	2.1

Of course, in a great many of these cases lesions were found in a number of organs, and sometimes they were distributed throughout the abdominal and thoracic cavities. No reference is made to lesions in the brain, skin, muscles, bones or joints, because these parts were not examined in all cases.

The next table is taken from the report of the Commissioners on Diseases of Domestic Animals of Connecticut for the year 1896, and is made up from the post-mortem records of 878 animals.

In 135 cases,	15.4 per cent.,	lesions found in	retro-pharyngeal glands.
In 287 cases,	32.7 per cent.,	" "	" mesenteric glands.
In 101 cases,	11.5 per cent.,	" "	" portal glands.
In 533 cases,	60.7 per cent.,	" "	" liver.
In 431 cases,	49.0 per cent.,	" "	" peritoneum.
In 26 cases,	3.0 per cent.,	" "	" uterus.
In 688 cases,	78.4 per cent.,	" "	" lungs.
In 301 cases,	34.3 per cent.,	" "	" bronchial glands.
In 501 cases,	57.1 per cent.,	" "	" mediastinal glands.
In 60 cases,	7.0 per cent.,	" "	" udder.
In 347 cases,	38.4 per cent.,	" "	" pleura.

The Commissioners note that while the lesions may be located in any part of the body, there is a seeming tendency for the same part to be affected in the same herd. For instance, in one herd the throat may be the part, and nearly all the infected animals will be found with lesions in that region. In another herd, it may be the liver or peritoneum in which the disease is most located. The same observation has been made by inspectors in Pennsylvania.

CHAPTER VI.

BACTERIOLOGY OF TUBERCULOSIS.

SUMMARY.

THE BACILLUS OF TUBERCULOSIS WAS DISCOVERED BY KOCH IN 1882, AND PROVEN TO BE THE ESSENTIAL CAUSE OF THE DISEASE. THE DISCOVERY HAS BEEN CONFIRMED BY EVERY ONE WHO HAS STUDIED THE MATTER EXPERIMENTALLY.

THE BACILLI ARE FOUND IN THE "TUBERCLES," AND IN DISCHARGES FROM DISEASED MEN AND ANIMALS, SUCH AS THE SPUTUM. THEY MAY BE CULTIVATED ARTIFCIALLY ON HARDENED BLOOD SERUM, AND ON OTHER MEDIA CONTAINING GLYCERINE. THE GROWTH IS SLOW, AND TAKES PLACE ONLY AT A CONSTANT TEMPERATURE NEAR THAT OF THE BODY.

THE BACILLUS IS PECULIAR IN ITS METHOD OF STAINING, AND IS READILY RECOGNIZED UNDER THE MICROSCOPE BY THIS FACT. SPORES HAVE NOT BEEN DEMONSTRATED.

IT IS KILLED BY A MOIST HEAT OF 140 DEFREES F. (60 DEGREES C.) IN 20 MINUTES, BUT WHEN DRY WILL RESIST 212 DEGREES F. (100 DEGREES C.) FOR ONE HOUR. IT IS KILLED BY A FIVE PER CENT. SOLUTION OF CARBOLIC ACID IN 30 SECONDS, AND IN ONE MINUTE BY A 1 PER CENT. SOLUTION. CORROSIVE SUBLIMATE 1-1000 IN WATER DESTROYS IT IN 10 MINUTES. SUNLIGHT IS RAPIDLY FATAL TO IT.

THE BACILLUS FROM DIFFERENT ANIMALS SHOWS SOME DIFFERENCES IN GROWTH AND VIRULENCE. THAT OBTAINED FROM CATTLE IS USUALLY MUCH MORE VIRULENT THAN FROM MAN. THE GERM FOUND IN BIRDS SHOWS MARKED DIFFERENCES FROM THAT IN MAMMALS. A TYPE IS FOUND IN FISH WHICH GROWS AT LOW TEMPERATURES, BUT HAS MUCH THE SAME MORPHOLOGY, AND STAINING REACTIONS. EXPERIMENTS INDICATE THAT ALL THESE FORMS HAVE A COMMON ORIGIN, AND MAY BE CONSIDERED AS VARIETIES OF THE SAME SPECIES.

TUBERCULIN IS AN EXTRACT OF THE TUBERCLE BACILLUS, WHICH IS LARGELY USED IN THE DIAGNOSIS OF THE DISEASE IN CATTLE, AND TO SOME EXTENT IN THE DIAGNOSIS AS WELL AS TREATMENT OF TUBERCULOSIS IN MAN. IT HAS SOME CURATIVE EFFECT. THERE ARE SEVERAL FORMS OF TUBERCULIN. THE OLD FORM WAS A GLYCERINE EXTRACT OF THE BACILLI, WHILE THE NEWER TUBERCULINS CONTAIN THE ACTUAL SUBSTANCE OF THE BACILLI, WHICH ARE SO FINELY GROUND UP THAT THEY PRACTICALLY GO INTO SOLUTION. THE OLD FORM IS GENERALLY USED FOR TESTING CATTLE, WHILE THE NEWER FORMS ARE MORE USED IN TREATING THE DISEASE IN MAN.

Historical.—The discovery of Villemin that tuberculosis was a contagious and inoculable disease, with his prediction that the virus was a living entity coming from outside of the body, led some observers to search for the organism which produces the trouble. Already germs had been found in some other diseases, notably anthrax.

In 1877 Klebs studied tubercular products by means of his method of fractional cultures. He obtained a growth which, injected into the peritoneal cavity of animals, produced, according to him, tubercles, identical with those which resulted from the inoculation of the tubercular products themselves. He concluded that this organism to which he gave the name of "monas tuberculosum," was the living cause of tuberculosis.

His researches were repeated by Schüller, who obtained like results and found an organism which he considered identical with that obtained by Klebs.

Toussaint, in 1881, by cultural methods obtained an organism which he considered the cause of the disease. Subsequent examinations of tissues coming from animals which had been rendered tubercular by Touissaint by injections with his organism, showed the presence of genuine tubercle bacilli, so that we now know that in cases where animals really became tubercular through these injections there must have been some genuine tubercular products which contained the true tubercle bacillus.

In 1882 Robert Koch, of Berlin, announced his discovery of the tubercle bacillus, which has stood the test of time, and is universally accepted as being the real cause of the disease. Koch's success was due in part to the introduction of the aniline dyes in the staining of bacteria, but more still to his indomitable perseverance and ability.

Description of Tubercle Bacillus.—The bacillus of tuberculosis is a slender rod, with rounded ends, from 2 to 5 microns in length and about three-tenths of a micron in thickness, or about one-fourth to one-half the diameter of a red blood cell in length. Thus in proportion to their length they are comparatively thin organisms. Occasionally, both in cultures and in tissues, forms as much as eight microns in length are found. The rods are straight or slightly curved, and occur singly, in pairs, or in little bundles. Quite frequently they cross one another so as to form Y shapes, and especially as seen in sputum, this is considered more or less characteristic.

According to Crookshank's observations, "The bacilli in tissue sections of bovine tuberculosis are shorter and less granular than those of human tuberculous sputum, but in milk they are quite as long, and even longer, and very distinctly granular or beaded, and are thus brought much closer morphologically to the bacilli in human

sputum. Speaking generally, however, the average length of the human bacilli is greater than the average length of the bacilli in cow's milk, but the longest of the bovine bacilli cannot be distinguished in length from the longest human bacilli. There are however, exceptional cases, for in some preparations of pus from human lungs, the bacilli are remarkable not only for their thinness and their uniformly beaded character, but more particularly for their extraordinary length. * * * * "Neither length nor granularity is a characteristic sufficient to denote any specific difference between human and bovine bacilli. * * * * Thus morphological differences are found under different circumstances, and within limits, the morphology of the tubercle bacillus varies with its environment."

In my own observations the longest bacilli that I have ever observed, excepting in old cultures, have been obtained from the coughed-up sputum of a cow. These bacilli were slender and a few of them as much as three times the usual length as seen in human sputum, and showed well marked beading. From the lungs of a pig, however, which had been fed on the milk of this cow and thus contracted tuberculosis, I obtained tubercle bacilli which in all respects could not be distinguished from those usually met with in human sputum, showing that in some instances at least, variations in morphological characteristics are due to the soil in which the bacillus is grown and not to any inherent difference in the germs themselves.

In stained preparations they frequently appear beaded, this appearance being due to the occurrence of small uncolored areas along the length of the rod, with deeply stained parts in between. In such extremely minute organisms it is difficult to make out the exact character of the unstained areas. By some observers they are considered to be of the nature of spores, but it is impossible to stain them by any of the known methods for staining spores, and consequently others consider them to be vacuoles, which are possibly produced during the process of staining. In the same specimen of sputum, varying amounts of beading can be brought out by different processes of staining. For instance, by Gram's method it is usually more marked than by carbol-fuchsin. Some believe that the deeply stained areas sometimes observed indicate spore formation. As a rule it may be said that the younger bacilli stain evenly, while in the older germs this inequality of staining is seen. Some authorities state positively that spore formation takes place. Thus Crookshank says: "In old cultivations true spore formation can readily be observed both in stained and unstained preparations." Others consider that it forms spores in the tissues, but not

in cultures. Spore formation has not been definitely proved and it is doubted by many. It may be stated that in many ways the bacillus acts like a spore-forming organism. Tissues taken from tubercular areas in the body will often produce tuberculosis, when by staining methods we cannot detect the presence of any bacilli. The resistance of the germ to destruction by putrefaction and its tenacity of life when dried, seem to indicate the presence of spores, while on the other hand it is rapidly destroyed by chemical antiseptics.

The tubercle bacillus is a non-motile, faculative anaerobic organism, and until recently has been considered a strict parasite. In cultures it usually occurs singly, though sometimes chains of two or three are observed, and in old cultures filamentous and branched forms are not infrequently met with. These filaments may be swollen or clubbed at their extremities and be irregularly beaded. Such forms are seen particularly in cultures derived from birds, and have been studied by Nocard and Roux, Metchnikoff, Maffucci, Klein and others.

Distribution in lesions.—In the tissues the bacilli grow scattered irregularly or in little masses, either singly or in twos, end to end, often forming thus, an obtuse angle. They may occur in numbers forming such masses that they are easily visible under low powers of the microscope, or else there may be a very few and exceedingly hard to find, as for instance in skin lesions or in old chronic lesions which have undergone caseation.

As a rule in chronic lesions, whether they be nodules with connective tissue formation or old caseous areas, they are few in number. In such material a few bacilli faintly stained are sometimes seen and also very minute unequally stained granular points, which may be spores, the best evidence of which is, as remarked before, that such material in which no bacilli can be found, may still prove virulent on inoculation into animals. The bacilli are most numerous in acute tuberculous lesions, especially where caseation is rapidly advancing, for example in such conditions as caseous catarrhal pneumonia. In less acute lesions with well formed tubercle follicles and little caseation, the bacilli are generally very scanty. In the ox, tubercle bacilli are often found in giant cells in considerable numbers, which is not common in the human being, and also they are found in considerable numbers throughout the cellular connective tissue of the lesions even when there is little caseation. In tuberculosis of the horse and avian tuberculosis, the number of bacilli may be enormous, even when the lesions are not very acute.

The bacilli are found commonly in large numbers in the discharges from tuberculous lesions which have undergone softening and breaking down. In the sputum of man, in the nasal secretion of cows, as

well as in the bronchial secretion, they can almost always be shown at some period of the disease. In tuberculosis of the urinary tract they may often be found in the urine—best by means of a centrifugal machine; and in tuberculosis of the intestine with ulcerations, their presence in the feces can be demonstrated.

Cultivation.—Koch first succeeded in obtaining a growth of the tubercle bacillus on coagulated blood serum. Later it was shown by Nocard that the addition of peptone, salt and cane sugar made a better culture medium, and later still Nocard and Roux have shown that it grows well on almost all culture media to which 5 per cent. of glycerine has been added, in fact it grows most abundantly on such media.

The bacillus will even grow, though very slowly, on gelatine to which glycerine has been added, and on potato, at 22 degrees C. (71.6 degrees F.). Grown on blood serum the colonies will appear from the tenth to the fourteenth day, as minute points of growth of a dull whitish color, irregular and slightly raised above the surface, an appearance compared by Koch to that of small dried scales. In sub-cultures the growth is more luxuriant and may form a wrinkled film of a whitish color which may cover the greater part of the surface of the medium, and the water at the bottom of the tube. Under a low power of the microscope these colonies can be seen extending at the edge in the form of wavy sinuous streaks, which have been compared to pen flourishes, and the smallest colonies are mostly S shaped.

The growth on agar containing 5 per cent. of glycerine is usually quite characteristic. The growth starts as minute whitish colonies which increase in size, and if the sowing has been abundant enough, soon coalesce to form a more or less continuous film which will cover a large part of the surface of the culture media. It becomes folded and wrinkled and of a creamy white color, the surface of the water at the bottom of the tube being also covered. In older cultivation the color may become creamy, and oftentimes is not unlike patches of lichen seen on trees. Some cultures are more granular than others, the membrane-like formation not being so marked. In all cultures, however, there is considerable tenacity, the bacilli clinging together in masses so that it is not easy to break them up. On bouillon to which glycerine has been added, growth is very rapid when kept at incubator temperature, and if the culture is made to float on the surface. Under these circumstances the growth is very rapid when kept at incubator temperature, and if the culture is made to float on the surface. Under these circumstances the growth spreads from the periphery and soon covers the entire surface of the liquid, then becoming folded and wrinkled, occasionally being of a granular character and spreading to a considerable extent up the

wall of the vessel at the edges. The bouillon always remains perfectly clear, and any clouding is a sure indication of contamination by some other organism.

Temperature.—The tubercle bacillus grows best at from 37 to 39 degrees C. (98.6 to 102.2 degrees F.); it ceases entirely at 42 to 43 degrees C. (107.6 degrees F. to 109.4 degrees F.), and usually below 28 degrees C. (82.4 degrees F.), though by continued cultivation at lower temperatures it may grow at 22 degrees C. (71.6 degrees F.).

Methods of staining.—The staining reactions of the tubercle bacillus are characteristic. One of the difficulties in the way of its discovery was its inaptitude to take up the stains in use. Koch first succeeded in coloring it by a solution of methylene-blue to which caustic potash was added, in which it was left for a number of hours. He soon abandoned this in favor of a solution of gentian violet, in water saturated with analine oil, introduced by Ehrlich. At the present day the use of the Ziehl-Neelsen carbol-fuchsin solution has practically superseded all other methods, except for the staining of sections of tissues, and even for this purpose it is one of the best methods. As used at present it is made by adding 11 cubic centimeters of a saturated solution of fuchsin in alcohol to 100 cc. of a 5 per cent. solution of carbolic acid, the carbolic acid acting as a mordant.

The peculiarities of staining shown by the tubercle bacillus consists in the difficulty with which it takes up the staining material, but having once taken it up, it parts with it with even greater difficulty; hence in preparations of sputum, pus, and so forth, we are able to give the tubercle bacilli one color, while other bacteria, pus cells, etc., which may be present are stained in a second color; or what seems to me better practice for ordinary purposes, we may remove the color from everything else and leave the tubercle bacilli brightly stained in an uncolored field.

In thin layers the tubercle bacillus is stained by boiling carbol-fuchsin in one minute, and by cold fuchsin in 20 minutes. The procedure is as follows for sputum, pus or such like material: Spread a small particle of the suspected matter in as thin a layer as possible over a clean cover glass; allow it to dry in the air or high above a gas flame at a temperature which will not burn the hand; then pass through the flame of a Bunsen burner three times with about the rapidity which one would wave a handkerchief at a friend. This is done for the purpose of fixing the preparation, or, in other words, of coagulating the albumen, so that the elements will remain fixed to the glass, and in their normal relations. The cover glass is then held between special forceps and the stain dropped on it until the whole glass is well covered, taking care not to add so much that it will run over. It is then heated over the flame until boiling commences, and is kept at this temperature for two or three

minutes, according to the thickness of the layer on the glass. If properly spread, one minute at the boiling temperature is sufficient but in practice it is safer to allow it to remain the length of time first given. By this process we stain equally everything on the glass, all bacteria, pus, epithelial scales, and so forth, and the tubercle bacilli cannot be distinguished from other bacteria which may be present.

As has been said, the tubercle bacillus parts with color which it has once taken up, with even greater difficulty than it absorbs it, a characteristic which belongs to it alone of all bacteria which are at present known. Our next step, then, is to remove the color from everything else in the preparation, which can be done without fear of depriving the tubercle bacillus of its stain. It may be washed in strong solutions of the mineral acids, such as 33 per cent. nitric acid, or 25 per cent. sulphuric acid, but it is better to use a milder decolorizer. In my experience the best is made by adding 5 parts of nitric acid to 95 parts of 80 per cent. alcohol. By the use of this preparation there is practically no danger of leaving the preparation in the decolorizing solution for too long a time, such as exists when the stronger acids are used. The preparation is washed alternately in this solution and in plain water until all color disappears, as seen by the naked eye, or until only a faint pink is visible. It is then mounted in water or in Canada balsam and examined under the microscope, when the tubercle bacilli will be seen as brightly stained rods in a practically uncolored field. If one prefers, the other matter in the preparation may be counterstained by some contrasting color, the best of which is probably blue.

Two other bacteria, the bacillus of leprosy and the smegma bacillus show staining characteristics somewhat like the tubercle bacillus, and also resemble it in their morphology. The diagnosis is usually easy. The bacillus of leprosy stains much more easily than the tubercle bacillus and stains easily even with cold aqueous solutions of the aniline colors. Its grouping, packed in the lepra cells, is also characteristic.

The bacillus of smegma may be differentiated by the following means: If we submit it to the action of a warm solution of soda containing 5 per cent. of alcohol for ten minutes and then wash carefully in water and in alcohol, we will entirely remove the fatty matter which they contain and such preparations do not stain by the method of Ehrlich, while the tubercle bacillus is not affected by this treatment. It may be known also by the fact that when stained by the carbol-fuchsin method, it resists decolorization by mineral acids, but gives up the stain readily when treated with alcohol.

Thermal death point.—The thermal death point of the tubercle bacillus is about 70 degrees C. (158 degrees F.). Sternberg found

that tuberculous sputum exposed for ten minutes to a temperature of 66 per cent. C. was not virulent for guinea pigs. Another specimen of the same sputum heated to a temperature of 50 per cent. for ten minutes caused tuberculosis in a guinea pig; from which he placed the death point between 50 and 66 degrees C. (122 and 150.8 degrees F.).

Yersin by culture methods did not obtain growth from bacilli which had been heated to 70 degrees C. (158 degrees F.), for ten minutes, while those heated to 55 and 60 degrees C. (131 and 140 degrees F.), gave growths in glycerine bouillon in 10 and 22 days respectively. McFadyean and Hewlett found that milk to which powdered dried sputum had been added was rendered harmless by a momentary heating to 67-68 degrees C. (152.6-154.4 degrees F.). Experiments by the Royal Commission on Tuberculosis, with tuberculous milk gave somewhat irregular results. In one instance milk which was heated to 65 degrees C. (149 degrees F.), for two and one-half minutes was harmless, while in another instance after five minutes at 70 degrees C. (158 degrees F.), it still retained its virulent properties to some degree, but twelve minutes at the same temperature rendered it inert.

It is stated by Muir and Ritchie that when completely dried they can withstand a dry temperature of 100 degrees C. for one hour. Grancher and Ledoux-Lebard found that the avian tubercle bacillus grew after being heated for 50 minutes to 50 degrees C. (122 degrees F.), but was killed by this temperature in 60 minutes. It grew after 10 minutes at 60 degrees C. (140 degrees F.), but was killed in 20 and 30 minutes. All cultures heated to 70 degrees C. (158 degrees F.), and above were killed in one minute, while at 100 degrees C. (212 degrees F.) one-half minute destroyed them. Those cultures which survived, grew more slowly than normal. The virulence of the germ was not affected by heating to 50 degrees C. (122 degrees F.), for 15 minutes, but heating to 60 degrees C. (140 degrees F.), and above lessens the virulence rapidly. These results were obtained with moist heat. For the human bacillus they found that growth took place after moist heating to 50 degrees C. (122 degrees F.), for 15 minutes, but were killed in the same time by heating to 60 degrees C. (140 degrees F.). It begins to lose its virulence in 5 minutes at the latter temperature. Cultures heated to 70 degrees C. (158 degrees F.), for 1, 2, 5 and 10 minutes, lost their virulence, and one-half minute at 100 degrees C. (212 degrees F.), produced the same result. When dried, the human bacillus maintains its virulence when subjected to a dry heat of 79 degrees C. (158 degrees F.), for seven hours; at 100 degrees C. (212 degrees F.), the virulence is gradually lessened, but not entirely destroyed even after three hours.

De Man has tested the effect of moist heat in destroying the virulence of natural products, such as milk from tubercular cows, puru-

lent fluid from tubercular udders, tuberculous sputum, and also suspensions of tubercular nodules, etc., made by rubbing them up with water containing salt. In such fluids he found that the bacilli were killed as follows:

At 55 degrees C. (131 degrees F.), at the end of 4 hours.
At 60 degrees C. (140 degrees F.), at the end of 1 hour.
At 65 degrees C. (149 degrees F.), at the end of 15 minutes.
At 70 degrees C. (158 degrees F.), at the end of 10 minutes.
At 80 degrees C. (176 degrees F.), at the end of 5 minutes.
At 90 degrees C. (194 degrees F.), at the end of 2 minutes.
At 95 degrees C. (203 degrees F.), at the end of 1 minute.

The recent work of Theobald Smith, which has been confirmed by Russell, proves that when precautions are taken to insure the even and thorough application of the heat to the tubercle bacilli, they are killed more easily than has been heretofore believed. When heated in milk, the bacilli may be carried into the pellicle which forms on the surface, and be protected from destruction to a certain extent. In this way the irregular results obtained by different observers which have been given above may be accounted for. Smith concludes:

1. "Tubercle bacilli when suspended in distilled water, normal salt solution, bouillon and milk, are destroyed at 60 degrees C. (140 degrees F.), in 15 to 20 minutes. The larger number are destroyed in 5 to 10 minutes.

2. "When tubercle bacilli are suspended in milk, the pellicle which forms during the exposure at 66 degrees C. may contain living bacilli after 60 minutes.

Russell has employed this new standard on a commercial scale for more than a year at the University of Wisconsin, and in a recent publication gives the following conclusions:

1. "An exposure of tuberculous milk in a tightly closed commercial pasteurizer for a period of ten minutes destroyed in every case the tubercle bacillus as determined by the inoculation of such heated milk into susceptible animals like guinea pigs.

2. "Where milk was exposed under conditions that would enable a surface pellicle or membrane to form on the surface, the tubercle organism is able to resist the action of heat at 140 degrees F. (60 degrees C.), for considerably longer periods of time.

3. "Efficient pasteurization can be more readily accomplished in a closed receptacle such as is most frequently used in the commercial treatment of milk than where the milk is heated in open bottles or vats.

4. "It is recommended in order to thoroughly pasteurize milk so as to destroy any tubercle bacilli which it may contain, without in any way injuring its creaming properties or consistency, to heat the same

in closed pasteurizers for a period of not less than twenty minutes at 140 degrees F. (60 degrees C.).

"Under these conditions one may be certain that disease bacteria such as the tubercle bacillus will be destroyed without the milk or cream being injured in any way."

Action of chemical disinfectants.—Yersin found that the tubercle bacillus was killed by a 5 per cent. solution of carbolic acid in 30 seconds, and in one minute by a 1 per cent. solution; by absolute alcohol in five minutes; by corrosive sublimate in a solution of one to one thousand in ten minutes. Crookshank found that tuberculous sputum, when mixed with equal parts of a 5 per cent. solution of carbolic acid, became innocuous in a few minutes, even when no precautions were taken for breaking up the masses. It should always be remembered when disinfecting material containing albuminous matter, that many chemicals are rendered inert by combining with albumen, hence enough of the chemical should be used to satisfy the combining power of the albumen contained in the mixture, and still leave enough to act on the bacteria. The combination with albumen thus formed by some chemicals, protects the bacteria contained in the centre of the masses. For this reason corrosive sublimate is not a good material with which to disinfect sputum.

Effect of drying etc.—The tubercle bacillus is quite resistant to the effects of drying. Koch found that tuberculous sputum dried at the temperature of the laboratory was virulent for guinea pigs after eight weeks. Schill and Fischer showed that sputum when dried quickly, always preserved its virulence for four months; about the sixth month some inoculations succeeded, while some failed, but after seven months the virulence was entirely lost. In tuberculous sputum which had undergone putrefaction, they found virulent bacilli after six weeks. Galtier showed that tubercular tissues could remain virulent for as long as two months immersed in water, which was renewed from time to time. The bacillus retains both its power of growth and its virulence for a much longer time in sterile water. Chantemesse and Widal found cultures alive after 70 days of immersion in sterilized Seine water, though they had lost their virulence, while Straus and Dubarry found that the avian tubercle bacillus would live 115 days under the same circumstances. Sawizky experimented with tuberculous sputum by subjecting it to conditions such as are found when spread on the floors of dwellings, and found that it retained its virulence for two and a half months.

The tubercle bacillus also preserves its virulence in tissues for some time after burial and when putrefaction is far advanced. Cadiac and Molet obtained positive results by inoculation of fragments of tubercular lungs after burial for 167 days, and according to Schottelius this virulence is retained for several years.

Effect of light.—The tubercle bacillus is exceedingly sensitive to the action of light. Koch found that the bacilli were killed by exposure to direct sunlight in a few minutes to several hours, according to the thickness of the layer in which they were exposed. He found also that diffused light had the same effct, only not so rapid. Cultures placed near a window in broad daylight, but protected from the direct rays of the sun were killed at the end of five to seven days. Straus has also found that luxuriant cultures of the bacillus both from human and avian sources, grown on the surface of glycerine bouillon, were killed by two hours exposure to the direct rays of the sun on a summer day. Along with these flasks, he exposed to the action of the sun, cultures of the bacillus previously dried and spread in a thin layer on pieces of glass. At the end of a half hour they had lost both their virulence and their power of growth.

Experimental inoculation.—All animals which are susceptible to tuberculosis under natural conditions, and many which are immune, may be infected by inoculation with small quantities of pure cultures of the tubercle bacillus, which may be introduced under the skin, into the circulation or into the peritoneal cavity. Many animals may be infected by feeding with material containing bacilli, and by direct inhalation of bacilli suspended in air or a spray. Of all the domestic animals, the guinea pig is the most susceptible, the rabbit less so, and dogs have considerable powers of resistance. Cattle, sheep and swine are easily infected. The monkey is very susceptible to the disease.

As a general rule, when tubercle bacilli are introduced into the tissues of a susceptible animal, such as the guinea pig, a local swelling with induration occurs at the point of inoculation, which is well marked by the eighth to the tenth day. This swelling becomes softened and undergoes a cheesy change, and if superficial, an irregular ulcer results. The lymphatic glands in relation to the part, become enlarged about the second to the third week and soon undergo a caseous change also, the process extending to other glands along the lymphatics, and also involving in time those of the opposite side of the body. The blood-stream may become loaded with bacilli which are thus carried to organs throughout the body, producing a rapid general tuberculosis. While these changes are going on, the animal shows marked changes of nutrition, emaciates, becomes cachetic, and finally dies, sometimes within four weeks, though sometimes not for two or three months. As a rule, the spleen is the organ found most affected after death, but the liver and lungs often show marked changes also.

When the inoculation is made into the peritoneal cavity, death is usually more rapid. Post-mortem the omentum is found thickened

and infiltrated by a mass of tubercles, giving it, as it were, the appearance of being rolled up. Sometimes there occurs an acute eruption of numberless tubercles over the peritoneum. The retro-peritoneal and other lymphatic glands undergo enlargement and caseation.

When the injection is made into the circulation, a typical acute tuberculosis of rapid form is induced, and death occurs in about three weeks.

In more resistant animals such as rabbits, subcutaneous inoculation sometimes leads to generalized tuberculosis, and sometimes only to a local disease, depending on the virulence and dose of the culture.

Action of dead Tubercle Bacilli.—It has been shown first by Prudden and Hodenpyl, that dead tubercle bacilli when injected into the tissues in sufficient numbers can produce nodules like those caused by living bacteria. By intravenous injection of rabbits with cultures which had been killed by heat, these observers caused in the lungs small nodules in which they found giant cells occasionally, though no caseation ever took place, and there was more growth of fibrous tissue than is seen in the common tubercle. Straus and Gamaléia, who made a complete study of this subject, obtained results which were entirely confirmatory. They found that if the number of bacilli introduced into the circulation is large enough, tubercular nodules with well formed giant cells, and in which there are occasionally traces of caseation are produced. In some instances they used cultures which had been exposed to a temperature of 115 degrees for a number of hours, and on successive days, with the same results, and what is still more remarkable, they found that even after these bacilli had remained in the bodies of animals for several months they still retained their morphology and staining characteristics. Sub-cutaneous injection of dead bacilli, if in any number, produces local abscess without subsequent involvement of the internal organs, though in many animals inoculated by various methods, into the circulation or into the peritoneal cavity, it produces a condition of marasmus leading to great emaciation, and death results.

Identity of the Tubercle Bacillus from various sources.—There has been considerable discussion as to the origin of the germs causing tuberculosis in the various mammals and in birds, and without doubt, cultures obtained from different sources show certain peculiarities of growth, morphology and virulence. Experiments by Dr. Theobald Smith would seem to indicate that pure cultures of the organisms obtained from cows are considerably more virulent for guinea pigs, rabbits and for cattle than are cultures obtained from tuberculous sputum of man. These results have been confirmed in the main by the work of Dinwiddie and ourselves, but

one would naturally expect the bacilli which have been grown in the bodies of certain animals for some time to be more virulent for that species than would bacilli coming from another source, and having grown in an animal (man) whose temperature is normally lower Even admitting all of the differences which are claimed, there are none of them which are marked enough to put in doubt the identity of the organisms. It is all but universally admitted that the bacilli as seen in different mammals are varieties of one and the same organism, the differences being due probably to differences in their surroundings.

Tuberculosis of birds.—For the bacillus as seen in birds, the case is somewhat different, though even here it seems that this organism may be regarded as only a variety of the other. Tuberculosis of birds affects almost exclusively the organs of the digestive apparatus. The liver is most often the most seriously affected; it is always very large and packed with tuberculous granules, sometimes to such an extent that it has the appearance of having been sprinkled with fine sand. The spleen is almost as often affected as the liver and is usually infiltrated with fine whitish granules. The intestine and peritoenum often show miliary tubercles, and in the wall of the intestine they not infrequently attain such a size as to obstruct the canal. The lungs are rarely affected. At times, lesions of the mouth, of the joints, of the pharynx, of the nose, and of the eye are seen. Whatever the location of the lesion, or its form, it is always exceedingly rich in bacilli, sometimes so thickly packed as to mask the anatomical elements. The bacilli appear generally a little longer than those which are met with in mammals, they have the same staining reactions, they grow well on the same culture media, though in general they appear more vigorous and grow more rapidly. They have greater power of resistance to destructive agents and live longer in cultures; they grow more quickly and more abundantly, everything being equal; they grow at a temperature of 43 degrees C. (109.4 degrees F.), a point which is above that at which the mammalian organism ceases to grow, and the cultures on solid media are not so tough, are softer and more greasy in appearance, and are easily spread on a cover-slip. Experimental inoculation shows differences, also, as cultures from human sputum usually fail to produce tuberculosis in birds, while those of avian origin readily do so.

Birds are very susceptible to the disease when fed with portions of the diseased organs of other birds, but numerous observers have found that they can consume large quantities of tuberculous sputum and other morbid products coming from man, without contracting the disease, though on the other hand there are many instances in which birds have become affected by eating such products; and tuberculosis has been observed in chickens raised around abat-

toirs, where they obtained pieces of diseased meat and tubercu-large organs. Also when the avian tubercle bacillus is inoculated into guinea pigs, the effects are very different. Guinea pigs usually survive a sub-cutaneous inoculation, though they sometimes die, and in such cases, while no tubercles visible to the naked eye can be found, numerous bacilli may be present in the internal organs, such as the spleen. Intra-peritoneal inoculation, as well as intra-venous injection are both fatal to guinea pigs and rabbits, though even in these cases there is no formation of tubercles, as ordinarily seen following injections of human tubercle bacillus. In the same way the dog is refractory to intra-venous inoculation of large quantities of the avian tubercle bacillus, though it is susceptible to inoculation by the organism from a human source.

On the other hand, many observers, such as Cadiot, Gilbert and Roger, Courmont and Dor, and Nocard, have shown that sometimes inoculation of chickens by the tubercle bacillus from a mammalian source succeeds, and when this is the case, subsequent inoculations are always successful, showing that the bacillus can undergo a change which makes one variety assume the character of the other. It has also been shown that the inoculation of guinea pigs with cultures of the avian tubercle bacillus sometimes produces ordinary tubercular nodules, and that after passing the bacilli through a number of guinea pigs in succession, they produce the general type of tuberculosis, so well described by Villemin.

From these facts we may conclude that the bacillus of avian tuberculosis is not a distinct and permanent species, but only a variety which has been modified by long growth in the tissues of birds. The change may be accounted for to some extent, perhaps, by the much higher temperature of birds than of men. The rabbit is practically equally susceptible to the bacteria from the two sources, though the type of lesions produced is different, but after two or three passages from rabbit to rabbit the lesions are so identical that it is impossible to tell their origin.

Fischel, by cultivation, on agar containing boric acid, and on eggs, has succeeded in making the mammalian tubercle bacillus grow according to the avian type. There are also several cases on record in which the bacilli cultivated from human cases showed an avian type, the probability being that the infection in these cases was from an avian source. The final argument in favor of the identity of all tubercle bacilli, is the fact that whatever be their origin, it is impossible to detect any sensible difference in tuberculin which has been made from the different cultures.

Experiments by Nocard.—Nocard has recently (1898) given new facts and experiments to prove the identity of avian tuberculosis with that seen in man and animals. He has for a long time observed that

tuberculosis in horses, which are naturally quite exempt from the disease, assumes two types, which are readily distinguishable clinically, an abdominal type and a pulmonary type, the difference being due to the origin of the infection. The pulmonary type corresponds to an infection from human origin; the abdominal type to an avian origin.

In studying the sputum of a tubercular man by inoculation into various animals, he found that it killed the rabbit as did avian tuberculosis, but that it was seldom virulent for guinea pigs. He obtained pure cultures, after several passages through rabbits in succession, and found that they were identical with those of avian tuberculosis. From this he infers that the consumption of tubercular poultry is not without danger to man. In an attempt to transform the character of the bacillus of human tuberculosis, Nocard inserted into the peritoneal cavity of chickens little sacs of collodion containing glycerine bouillon inoculated with cultures of the tubercle bacillus. After these sacs have remained from five to eight months in the peritoneum of a chicken they are found to contain only a sort of mortar-like substance made up of bacilli, from which cultures could be obtained, showing that in spite of the long period of time during which they had remained in this condition they had retained life. The cultures showed most often the characteristics of the avian bacillus. They thrived at temperatures above that at which the human tubercle bacillus will grow. They had lost entirely the dried scaly appearance they formerly possessed before their sojourn in the body of the chicken.

Inoculation of this material into chickens most often was without effect, probably because the change of character was not complete, but after passing through several chickens in succession, from one to the other, during four to six months, the culture then became almost always fatal to chickens. In one month's time this culture was fatal to rabbits, with the production of lesions identical with those produced by the avian bacillus. In one of his experiments he allowed a sac to remain eleven months in the chicken. Seeing that it was sick and wasting away, he killed it, and found that it had become tubercular; imbedded in a mass having a sacromatous appearance he found the little sac which had been inoculated with tubercle bacilli, torn. In this way bacilli had accidentally been set at liberty in the peritoneal cavity after a period of time during which their transformation into the avian type had become well advanced. In this case the transformation of the culture took place without the successive passages. These observations go to prove that the bacilli as seen in birds and in man are not two different species but only two varieties of the same species.

Tuberculosis of fish.—In 1897 Dubard, Terre and Bataillon found in fishes affected with tuberculosis, which had for its origin the

eating of the sputum and dejections of a tubercular person, an organism which they named "bacillus tuberculosus piscium," which grows best at low temperatures and does not bear high temperatures well, except after a considerable period of acclimatization. In this we have further evidence of the unity of origin of all the different forms of the tubercle bacillus, the modifications being apparently due solely to the soil and conditions under which it was grown. Examination of cultures and a complete study of the organism thus isolated has confirmed the identity of origin of this bacillus and the tubercle bacillus of Koch. The circumstances of this discovery are interesting. The sputa and dejections of a woman well advanced in tuberculosis of the lungs and intestines had been constantly thrown into a stream used for fish culture. Eight carp, six of which became afterwards affected, had passed an entire year in the same reservoir with trout. Some years before the same reservoir had contained hundreds of carp which remained in good health, and about twenty had passed fourteen months there without being infected, hence some local cause must be looked to to explain the breaking out of the disease in these fish. It was first noticed in the fall of 1896. An inquiry showed that a constant contamination by the products from a tubercular person had been taking place in this part of the brook during the years 1895 and 1896, which had started sometime before the putting of these carp in this part of the stream. At this point the stream formed an eddy where the current was very slight, thus attracting the carp, and which also allowed the tubercular products to fall to the bottom of the stream. These fish showed lumps on their sides, were deformed, their color became dark and the abdomen voluminous. The study of the cultures obtained from these tubercular fish have confirmed the opinion that this was a genuine tuberculosis, and the mode of contagion is undoubted.

The bacillus thus obtained grows best between 22 degrees and 27 degrees C. (71.6 degrees F. to 80.6 degrees F.), but grows as low as 10 degrees C. (50 degrees F.). Above 34 degrees C. (93.2 degrees F.) growth ceases or becomes very slow, but by frequent replantings and by gradually raising the temperature at which these successive cultures are kept, it is possible to obtain one which will grow at 37 degrees C. (98.6 degrees F.). The cultures, after having become accustomed to an artificial life, form quite a thick membrane on the surface of the medium and also push up a little on the walls of the vessel. The odor of cultures is identical with that of the human tubercle bacillus. From the twentieth day up to the thirty-fifth they have the same odor as corresponding cultures of the tubercle bacillus of the same age. It stains deeply by cold carbol-fuchsin in a few minutes, but having taken the stain, resists decolorizing strongly. It is not pathogenic at first for rabbits, birds or guinea

pigs, but is virulent for all cold blooded animals on which it has been tried, such as carp, tritons, frogs, toads, tortoises, lizards, serpents, water snakes and vipers. By successive passages through guinea pigs and rabbits it becomes virulent for these animals, and causes unquestionable lesions of tuberculosis in the liver, spleen, and in one case, of the lung. From these organs bacilli were obtained which differed in no respect from the ordinary human tubercle bacillus. So large a proportion of the guinea pigs experimented on became tubercular that the idea of an accidental contamination could not be entertained.

A thorough study of the morphology and biology of this organism by Dubard and Kral have led them to the positive conclusion that this is not a new species of organism but a modification of the tubercle bacillus as seen in warm blooded animals. It has been demonstrated that by passing the bacillus of Koch through cold-blooded animals, it acquires the property of growing at lower temperatures than that of the body, but at the same time, these cultures which have a perfect resemblance to ordinary cultures of the tubercle bacillus, lose their virulence for warm-blooded animals.

These discoveries have shown us that the tubercle bacillus has great power of adaptability. They show also that the bacillus is not the strict parasite which we have heretofore considered it, but that it may accustom itself to almost any surroundings in which it is placed, and may possibly lead a saprophytic life. "This power of adaptation to different surroundings possessed by the tubercle bacillus introduces this further element of danger, that as it becomes adapted to its life in a given animal, or in different members of a closely bred herd of cattle, in the natural course of events it must become better and better adapted to survival in that particular animal and breed, and hence increasingly dangerous to all of its members. This is one reason why tuberculosis is so liable to get intensified in special herds of thoroughbred stock and why common cattle with their varied ancestry will sometimes seem to afford longer resistance to the affection. It may also explain the fact that with ample exposure the disease does not always pass from man to cattle and from cattle to man, yet it would be folly to argue from such data, that the disease when present in an occult form in a herd may be safely neglected and that the products of such a herd may be safely consumed by man. The very adaptability of the tubercle bacillus sufficiently contradicts this conclusion. The mere continuous presence of the bacillus in a given system, human or bird, is the means of securing a better and still better adaptation to that form of life and a greater and still greater measure of potency, so that when the health of the host or exposed animal is in any way reduced, it may at once become deadly and far reaching in its evil effects."

PRODUCTS OF THE TUBERCLE BACILLUS.

Tuberculin.

In 1890, Koch announced at the National Congress of Berlin that he had succeeded after long trials in finding "a substance which inoculated into a guinea pig rendered it immune to the inoculation of the tuberculous virus; this same substance in guinea pigs already affected with advanced and generalized tuberculosis caused a complete arrest in the development of the disease, so that under the influence of this remedy the animal felt no bad effect." Three months after, he gave the results of the employment of this remedy in tubercular men with regard to its curative effects and its diagnostic value. To this preparation he gave the name tuberculin. The announcement of this discovery in some respects made a greater sensation than did the announcement of the discovery of the tubercle bacilli, and from all parts of the world, students, as well as tubercular people, flocked to Berlin, the former to learn the methods of the new cure which it was believed had been discovered, the latter to take advantage of the hope thus held out to them of regaining health and preserving life. Unfortunately, these hopes have not been realized, and tuberculin is now no longer believed to have the power of curing the disease, although we occasionally have reports of its beneficial use in the human subject. Its great value, however, has proved to be in the diagnosis of the disease as seen in cattle, and for this purpose, its use is steadily increasing, while every observer the world over gives it the highest place. Its method of use and the results obtained by it are fully discussed in another part of this report.

Tuberculin may be described, roughly, as a glycerine extract of the tubercle bacillus. It is a brownish or dark amber colored liquid, somewhat syrupy owing to the fact that it contains 50 per cent. of glycerine, and has a characteristic aromatic odor, which is rather attractive, and described by some German writers as being fruity and delightful. It keeps well, owing to the amount of glycerine it contains, and may be preserved indefinitely in a cool, dark place. It should, however, be preserved in sterile, well stoppered bottles, and, according to Koch, is good as long as it remains clear. It should never be used in its pure condition, but should be diluted with a one per cent. solution of carbolic acid. If diluted simply with water the solution very rapidly spoils.

Preparation of Tuberculin.—It is prepared by growing the tubercle bacillus in a broth made from the flesh of veal, to which is added dried peptone in the proportion of one per cent., common salt in the proportion one-half of one per cent., and glycerine in the proportion of 5 per cent. In making

the cultures it is necessary to make a small particle float on the surface of the liquid. The cultures are kept at the temperature of the body, or preferably slightly above, between 37 and 39 degrees C. (98.6 to 102.2 degrees F.), for from six to ten weeks. The little island soon extends itself over the entire surface of the liquid and becomes thrown into folds and wrinkles, and pushes itself up to some extent on the walls of the vessel at the edge of the liquid. When the growth is sufficient, the whole mass is sterilized either in an autoclave at 115 degrees C. (239 degrees F.), for 15 minutes, or else in the steam sterilizer for from one to two hours. The masses of bacilli are next filtered out through ordinary filter paper, and the liquid evaporated over a water bath to one-tenth of its volume, and then passed through a porcelain filter. Or else the whole mass is put together in a water bath until concentrated to about one-tenth of the original volume and the bacilli then filtered out. This was the original way of making it, but the way first given is much more convenient and renders the subsequent filtration through porcelain more rapid and easy. An abundant growth of the germs seems to be necessary to obtain a tuberculin of good strength, but it is not necessary to have a virulent culture.

Discovery of Tuberculin.—Koch was led to the discovery of tuberculin by observing the different action following the sub-cutaneous inoculation of a virulent culture of the tubercle bacillus in guinea pigs, which were already diseased, and in those which were healthy. In a healthy guinea pig such an inoculation caused a typical tuberculous ulcer which remained until the death of the animal. If the guinea pig is already diseased we notice about the tenth day that the skin at the point of inoculation takes on a deeper color and becomes indurated; soon there is an area of necrosis which sloughs off, leaving a clean ulcer which heals quickly and without infection of the corresponding lymphatic glands. This action was obtained not only with living germs, but also with cultures killed by heat or by other means. Dead cultures injected under the skin of healthy guinea pigs only determine a local abscess. Koch says: "This same injection in a much smaller dose, leads on the contrary to the death of tubercular guinea pigs at the end of from 6 to 48 hours, according to the dose employed; if the dose injected is too small to cause death in the animal, it provokes an extended necrosis of the skin at the point of injection. If the dose of the bacilli is smaller still the animal remains living, and when similar injections are repeated every day, or every other day, there is soon noticed a marked improvement in the condition of the guinea pig. The tuberculous ulceration does not extend and finally cicatrizes, a termination which one never sees in cases not treated. The enlarged lymphatic glands grow smaller, the general induration is modified and the morbid process is arrested, if the case

has not been too far advanced and the animal too much weakened." This observation was the starting point of his method of treatment against tuberculosis. Koch's theory of the action of tuberculin was that ordinarily the tubercle bacillus secretes a substance which has a necrotic action on the tissues and this substance is contained in tuberculin. When tuberculin is injected into an animal suffering with tuberculosis, the quantity of the substance producing necrosis of the tissues around a tubercular focus is suddenly increased, and necrosis of the margin spreads very rapidly. Inflammatory reaction takes place around, and the material containing the bacilli either dead or living is thrown off as a slough instead of disintegrating more slowly.

Tuberculin injected under the skin possesses active and remarkable qualities, but taken into the stomach it has no effect. Man is very much more sensitive to its action than is the guinea pig. We can inject under the skin of a healthy guinea pig as much as two cubic centimeters of tuberculin not diluted, without causing any appreciable effect, but if they are tubercular, a dose of 1-100 part of a gram will cause death, if the disease is well advanced. If less advanced, a dose of two to three-tenths of a gram may be required, but a dose of one-half gram always proves fatal. The post-mortem appearances are quite characteristic and consist of congestion of the lymphatics and the viscera. On the liver and spleen may be seen dark red spots, from mere points to the size of hemp seed, which are due to the enormous dilatation of the capillaries in the immediate neighborhood of tuberculous deposits. These hemorrhagic spots on the liver are considered almost certain evidences of death from tuberculin.

Action on man.—The minimum dose which produces any effect in a healthy man is one one-hundredth of one cubic centimeter. In this dose it causes only generally slight weakness. The action of a like dose, one one-hundredth of a cubic centimeter, on one suffering from tuberculosis is very different. It causes a well marked local and general reaction, which begins usually with a chill, the temperature rising to 39 degrees C. (102.2 degrees F.), 40 degrees C. (104 degrees F.), and even 41 degrees C. (105.8 degrees F.), with cough and muscular weakness. These symptoms commence ordinarily about the fourth or fifth hour and last from 12 to 15 hours. Even doses of 0.0003 gram will give a reaction in tubercular individuals. Local reaction, which is best observed in those having external tubercular diseases, such as lupus, is well marked. A few hours after the injection, which is usually made at a point some distance from the lesion, the diseased areas become red and swollen, usually before the chill. The swelling of these areas diminishes usually when the fever lessens and in a few days has disappeared. The spots become then

covered with crusts formed of a dried serous exudate which fall at the end of two or three weeks, leaving a red shining cicatrix. The alterations described are limited exclusively to the diseased areas. The local reaction caused in tubercular glands and bones, while not so striking as in lupus, is still quite perceptible. In tubercular lungs the local reaction is manifested by an increase in the cough and expectoration, and it is probable that there is here an action not unlike that which can be seen openly in cases of lupus. By cautiously repeating the dose a toleration may be acquired so that considerable doses cause little or no disturbance.

Great improvement, especially in external lesions, apparently results in some cases, so much so that a cure is often believed to be effected, but unfortunately when the tuberculin treatment is stopped the scar may break down and the disease return, though in some cases a permanent cure seems to be effected.

Crude tuberculin contains, besides the active principle, all other products of the tubercle bacillus which are soluble in a 50 per cent. solution of glycerine, except those which are destroyed by the boiling temperature. The quantity of the active principle is certainly very small; it is estimated by Koch to be about one part in one hundred. From this, its extreme activity may be understood. If we filter the cultures and use only the bouillon in which the germs have been grown, a very slight reaction is given, although it is said that by heating the bouillon to 100 degrees C. (212 degrees F.), it has more nearly the effect of ordinary tuberculin. On the contrary, quite an active tuberculin may be extracted from the bacilli, from which we see that the active principle of tuberculin is no doubt a product elaborated within the body of the bacteria themselves. Gamaléia has injected into the circulation of rabbits as much as 20 cubic centimeters of the bouillon on which the tubercle bacilli have been grown without producing any appreciable effect. From the various studies that have been made on tuberculin, we conclude that the active principle is contained in the bodies of the bacilli and belongs to the group of nuclear proteids, and not, as was supposed by Büchner, to the group of toxalbumins, since the latter are destroyed rapidly by heating to 80 degrees C. (176 degrees F.), or 100 degrees C. (212 degrees F.), while the proteids resist a boiling temperature for many hours.

Purification of Tuberculin.—Numerous attempts have been made to get rid of the toxic substances contained in tuberculin and to retain only its curative properties. Koch has prepared one by precipitation with 60 per cent. alcohol, which he calls purified tuberculin. Similar preparations may be obtained by adding alcohol to tuberculin in a proportion of two parts to three, a white flocculent powder being

thus thrown down which can be purified by washing with 60 per cent. alcohol, and then with absolute alcohol, and drying in a vacuum. The powder thus obtained seems to contain all the active principles of tuberculin. It is soluble in water but loses its activity very rapidly. A solution in 50 per cent. glycerine and water is very stable and retains its active properties for many months unchanged. These solutions may be heated in the autoclave to a temperature of 130 to 160 degrees C. (266 degrees F.), for several hours without being changed. This purified tuberculin gives all the proteid reactions; it contains sulphur and from its reactions and elementary analysis, evidently belongs to the proteid group and is most closely allied to the proteoses. Klebs attempted to purify tuberculin by ridding it of its injurious properties. In his process he precipitated it with alcohol and treated the precipitate with a mixture of alcohol, chloroform and crystallized benzol. To this substance he gave the name of "tuberculocidin," from the effect which it seemed to have on the bacilli in tubercular subjects, provoking in them a degenerative change. Klebs claims to have obtained well marked curative results with this preparation, but general success has been but little more marked with this than with the older preparation.

The newer Tuberculins.—Koch has more recently devised three new modifications of tuberculin, the first, which he terms T. A. (Tuberculin Alkaline), is prepared by digesting cultures of the tubercle bacillus with a one-tenth normal solution of caustic soda, and then filtering. It causes much the same reaction as the original tuberculin, but relapses do not seem to occur so often. It causes abscess at the site of inoculation when used in any quantity, which forms an insuperable objection to it. The two other preparations are prepared by thoroughly triturating the tubercle bacilli, previously dried in a vacuum over sulphuric acid, until reduced to fine powder. They are then rubbed up in distilled water and put in a centrifugal machine which separates it into two layers. The upper one called T. O. (Tuberculin Oberst), consists of a whitish opalescent liquid; the lower one, which is called T. R. (Tuberculin Rest), consists of a muddy residue. This residue is dried, again triturated and run through a centrifugal machine as before, the operation being repeated until no residue is left.

These preparations are said never to cause abscess formation. The top layer after the centrifugalization is the only one which needs to be distinguished from the others, the liquids resulting from the succeeding operations being all alike in their action.

In making these tuberculins it is necessary that the cultures should be young and highly virulent. The trituration is exceedingly dangerous unless done by machinery. The T. O. closely resembles T. A. but has the advantage of not causing abscess formation. Its

immunizing properties are slight. T. R. is said to possess powerful immunizing properties and does not cause suppuration nor reaction. When healthy guinea pigs are treated with increasing doses of T. R., they become immune against virulent cultures of the tubercle bacillus. By treating guinea pigs previously inoculated with virulent cultures, by injections of T. R. a cure may be effected if the treatment is commenced within one or two weeks after the inoculation.

Oxytuberculin.—Still another modification of tuberculin has been made by Dr. J. O. Hirschfelder, of San Francisco, which consists of modifying the first tuberculin of Koch by means of peroxide of hydrogen. To this preparation he gave the name of Oxytuberculin. His results have been most encouraging and a committee reporting in the Lancet,January 15, 1898, gave the following conclusions:

"That oxytuberculin stops the growth of the tubercle bacillus; that in 15 cases treated they observed a distinct therapeutic value; and third, that it produced no dangerous effects."

All these preparations are still under judgment, and while here and there good results are reported, they have not come into general use, though we cannot help hoping from what has been done, that the day is not far distant when a cure will be found for tuberculosis, which will equal the results which have been given by antitoxine in diphtheria. At present it may be said that the chief use of tuberculin still remains in the diagnosis of the disease in cattle, though it is also employed in the production of serums for the cure of tuberculosis, and its use as a diagnostic agent in man is increasing.

Tuberculin is free from germs.—The prejudice against the use of tuberculin on the ground that it may cause tuberculosis in healthy animals is wholly without reason and must be the result of ignorance on the part of those holding to such an idea. It has been shown that momentary heating to 95 degrees C. (203 degrees F.), is fatal to the tubercle bacillus. In the process of making tuberculin as described above, it will be seen that the bacilli are subjected to the boiling temperature 100 C. (212 degrees F.), for at least one hour, and afterwards subjected to the temperature of a water bath during the period of at least six hours during the process of evaporation. Before being injected the tuberculin is diluted with a one per cent. solution of carbolic acid, with which it remains in contact never less than three days before use and most often from one to two weeks. One per cent. solution of carbolic acid is fatal to the tubercle bacillus in one minute, and there can be no possible chance of the bacillus escaping death in the solution as used for injection. But another safeguard exists in the filtration through the porcelain filter, which

has been proven time and again to arrest all germs, so that tuberculin contains absolutely no living or dead bacteria, but only the products of the growth of the organism. It would be as rational to plant the coffee as we drink it and expect to raise the coffee plants with their berries as to look for the production of tuberculosis in animals by the injection of a few drops of tuberculin.

CHAPTER VII.

THE GENERATION AND SYMPTOMS OF TUBERCULOSIS.

SUMMARY.

TUBERCULOSIS STARTS IN THE BODY AT ANY PLACE WHERE THE GERMS OF THIS DISEASE LODGE AND GROW. THE GERMS USUALLY LODGE SOMEWHERE NEAR THE PLACE WHERE THEY ENTER, BUT SOMETIMES THEY ARE CARRIED A LONG DISTANCE BEFORE THEY SETTLE DOWN AND PRODUCE CHANGES IN THE TISSUES OF THE ANIMAL.

AFTER TUBERCLE BACILLI ENTER THE ANIMAL THEY MAY BE CARRIED FROM PLACE TO PLACE THROUGH THE TISSUES, OR THROUGH CANALS OR CAVITIES OR IN THE LYMPH OR BLOOD. IN THESE WAYS THE DISEASE SPREADS THROUGH THE BODY. ANY PART OF THE BODY MAY BE AFFECTED BY TUBERCULOSIS.

THIS DISEASE IS USUALLY SLOW IN ITS DEVELOPMENT, REQUIRING MONTHS OR YEARS FOR ITS FULL MATURITY. DURING A LARGE PART OF THIS TIME THE AREAS OF DISEASE ARE EXFOLIATING AND THE GERMS ARE BEING DISCHARGED FROM THE BODY BY ANY CHANNEL THAT IS IN COMMUNICATION WITH THE PART THAT IS DISEASED.

THE SYMPTOMS DEPEND ON THE LOCATION AND SIZE OF THE DISEASED PART OR PARTS.

IN THE EARLY STAGES THERE ARE NO SYMPTOMS BECAUSE THE DISEASED PARTS ARE CONCEALED WITHIN THE BODY AND ARE NOT LARGE ENOUGH TO NOTICEABLY IMPEDE THE FUNCTION OF THE ORGAN IN WHICH THEY ARE LCCATED. FOR EXAMPLE, IF 1-50 OF THE LUNG IS TUBERCULAR AND HAS LOST ITS FUNCTIONAL ACTIVITY, THE ANIMAL WILL GET ALONG VERY WELL WITH THE OTHER 49-50 AND NO DISTURBANCE OF BREATHING WITH RESULT. WHEN, HOWEVER, SO MUCH OF THE LUNG IS DISEASED THAT THE STILL ACTIVE PART IS OVERWORKED, SYMPTOMS OF DISEASE APPEAR. IT IS THE SAME WITH OTHER ORGANS.

IN ITS SYMTOMATOLOGY TUBERCULOSIS MAY BE COMPARED TO CANCER. BOTH DISEASES ARE ESSENTIALLY LOCAL AND SPREAD SLOWLY. THEIR SYMPTOMS RESULT FROM THE IMPAIRMENT OF THE FUNCTION OF A PART. THE CHARACTER OF THE SYMPTOMS DEPENDS UPON THE SITUATION AND CHARACTER OF THE LOCAL LESION. BUT TUBERCULOSIS BEGINS IN NEARLY ALL CASES WITHIN THE BODY, HIDDEN FROM VIEW AND MAY REACH A REMARKABLE DEVELOPMENT WITHOUT SERIOUSLY INCONVENIENCING THE ANIMAL BY DISTURBING THE FUNCTIONS OF ANY OF ITS ORGANS.

ONE OF THE MOST STRIKING AND IMPORTANT FACTS IN REGARD TO TUBERCULOSIS IS THAT IT MAY EXIST TO A DANGEROUS DEGREE FOR A LONG TIME WITHOUT PRODUCING SIGNS OF ILLNESS OR EVEN LOSS OF CONDITION.

OF THE USUAL SYMPTOMS OF ADVANCED TUBERCULOSIS THE FOLLOWING ARE THE MOST IMPORTANT: COUGH, EMACIATION WITH GOOD APPETITE, HARSH COAT, SUNKEN EYES, ENLARGED LYMPHATIC GLANDS, DULLNESS UPON PERCUSSION OVER THE LUNGS, SIBILLANT AND MUCOUS RALES AND, TOWARD THE END, RAPID EMACIATION WITH DIARRHOEA. TUBERCULAR CATTLE USUALLY BREED IRREGULARLY.

Tuberculosis begins as a local disease.—Tuberculosis always begins as a local disease at the point at which the tubercle bacilli are arrested and grow. The location of the point of primary infection depends largely upon the channel of infection. If the germs have been inhaled, disease is most liable to start at some part of the respiratory tract. If the germs have been taken in with the food or water, disease is liable to start at some part of the digestive tract, usually in the throat, small intestine, liver or mesenteric lymphatic glands. If infection is through the skin, tubercles will first form at the point of inoculation. If a cow is infected by a tubercular male, the disease will originate in the uterus. Sometimes tubercle bacilli are carried a certain distance from the port of entrance before they lodge and commence to multiply. Until recently it was denied that the tubercle bacilli could thus be carried from the point at which they are introduced without leaving an area of disease at that place, but it is now known that these germs may pass through the lungs and not cause discoverable disease until they reach the bronchial or mediastinal lymphatic glands. Similarly, tubercle bacilli may pass through the wall of the pharynx and produce no alteration of structure until they arrive in the post-pharyngeal lymphatic glands. It may be, and there are some observations that indicate, that tubercle bacilli may be carried much longer distances before they occasion visible disease.

The changes that result from the development of tubercle bacilli in living tissues are described on page 99.

The disease afterwards spreads to other parts.—After gaining a foothold in the body and after one or more tubercles are formed, the bacteria may invade other regions by passing through tissue, by being distributed mechanically in cavities or in canals or by being transported in currents of lymph or in the blood.

Progression of tuberculosis by continuity of structure is not rare and explains the invasion of the pleura from the lung, or of the diaphragm, and subsequently the pleura, when the peritoneum covering the abdominal side of the diaphragm is the seat of tubercles.

Infection may be carried from one part of the lungs to another by tuberculous material that is distributed through the bronchial tubes.

If tuberculous material is discharged into the pleural or peritoneal cavity, it is scattered by the movements of the animal and of the organs within these cavities, so widespread infection of the serous membranes lining them may result.

The lymphatic gland shows infection of correlated part.—Where tuberculosis exists in an organ, it is customary to find the lymphatic glands of that organ involved in a tuberculous process. The bronchial and mediastinal lymphatic glands are usually tubercular when the lungs are. Tuberculosis of the portal lymphatic glands follows tuberculosis of the liver and similarly, we find infection of the mesenteric lymphatic glands and of the supra-mammary lymphatic glands in tuberculosis of the intestines and of the udder respectively.

The most widespread infection occurs when tubercle bacilli enter the circulation. This accident results from the perforation of a blood vessel wall and the subsequent discharge into the blood current of the contents of a tubercle or tubercular abscess.

There is no part of the body that is exempt from the ravages of tuberculosis. Some parts, however, are more predisposed to the attacks of the germ than others; some tissues are better adapted for their growth than others and, therefore, the disease is more common in some organs than in others.

Acute miliary tuberculosis.—Where the germs are carried in the circulation and the form known as acute miliary tuberculosis develops, the lesions are distributed widely. This form of tuberculosis usually kills quickly and upon post mortem examination it is found that while the lesions are numerous and widespread, they are often of the young gray form and have not consolidated into the large, yellow, cheesy masses.

THE SYMPTOMS OF TUBERCULOSIS.

The symptoms of chronic Tuberculosis.—On discussing the symptoms of tuberculosis it seems best to divide the disease generally into two classes: (1) The chronic form, which is usual; and (2) the acute, miliary form, which is not so common.

The symptoms of chronic tuberculosis depend upon the location of the lesions and their extent. When the lesions are situated deeply and are not of great extent, they may occasion no visible symptoms of disease. In such conditions the infected animal may present the picture of perfect health and show no disturbance of function. Indeed, in some animals in which the lesions are both extensive and widely distributed and which have never presented noticeable signs of disease and are killed in prime condition for beef, the owner is astonished to learn that his supposed healthy animal contains large masses of tubercular tissue.

Since the lesions of tuberculosis vary so much in different cases, it is not possible to give a description of what can be designated the characteristic or even the usual symptoms of this disease. There are, however, some general symptoms that occur in most of the advanced cases, as emaciation, while the appetite continues good. This is always a suspicious indication and especially if accompanied by cough, rough coat and tight, harsh skin. Rough or loud breathing sounds are suspicious, and, in advanced cases, it is often found that the animal groans when pressure is brought to bear upon the chest wall. Many cases bloat habitually, and hard, painless swellings (enlarged lymphatic glands) beneath the skin in the region of the escutcheon, flank, shoulder or throat are suspicious.

Since tuberculosis of the lungs is more common than of any other organ, it was formerly the practice with some to examine these organs alone in inspecting cattle for tuberculosis. It is shown by the table above that about 60 per cent., or more than half of the cases of tuberculosis, are diseased in these organs, and some tables show as high as 75 per cent. of pulmonary infection. In tuberculosis of the lungs it may be said that coughing is the most noticeable symptom. Coughing is most common after feeding, drinking or after moving following a period of repose, but sometimes it occurs without any apparent cause. The cough is usually strong, dry and frequently of a high pitch. Sometimes it is very violent and accompanied by protrusion of the tongue. Auscultation reveals modified and abnormal sounds of different kinds in the lungs; sibilant, sonorous and mucous rales are most common. In some cases there are areas of complete silence showing that no air is entering the portion of the lung that is under examination. The dull sound is often detected on percussion. It is also to be noted that this condition is of slow development and long duration, thus aiding one to distinguish it, in many cases, from bronchitis or pneumonia.

Where the mediastinal lymphatic glands are enlarged and press upon the oesophagus, it is customary to find that the animal bloats habitually. Chronic or habitual bloating accompanied by good appetite and no other evidence of disease of the digestive tract, and especially if there is shortness of breath and cough, may be looked upon as strongly indicative of tuberculosis with enlarged mediastinal lymphatic glands.

Sometimes large tubercular masses develop on the pleura. In such cases the principal symptom is a friction sound that is heard most distinctly during the end of the act of inspiration. If the masses are large enough they give rise to a dull sound upon percussion. In tuberculosis of the stomach and intestines, digestion is interfered with. This gives rise to poor appetite, frequently to diarrhoea and sometimes alternations of diarrhoea and constipation. In tuberculosis

of the peritoneum or the lining of the abdominal cavity, the lymphatic glands of the flanks are often enlarged and hard. Sometimes this condition can be diagnosed positively by a rectal examination and the discovery by this means of the hard, nodulated masses. Tuberculosis of the liver does not give rise to any symptoms unless the disease is of very great extent, in which case jaundice may be observed.

In animals in which the post-pharyngeal lymphatic glands are enlarged from tuberculosis, the breathing is harsh and noisy. In this condition there is sometimes difficulty in swallowing, and particles of chewed up food are occasionally expelled from the mouth, either voluntarily, when it is found that they cannot be swallowed conveniently, or by the coughing that they occasion upon reaching the pharynx. These enlarged glands may sometimes be detected by palpitation accomplished by placing one hand on each side of the throat above the larynx and then pressing from opposite sides.

Tuberculosis of the udder is characterized by an enlargement and hardening of the affected part, usually by the absence of pain and the fact that the secretion is not altered until the part has been diseased for some time. In advanced cases, instead of milk, the udder secretes a yellowish, cloudy and sometimes flocculent fluid. In acute, rapidly developing cases, there may be pain and edema of the skin. In nearly all cases of udder tuberculosis the supra-mammary lymphatic glands, situated above the udder in the middle of the escutcheon, are enlarged and hard. If there is doubt as to the character of the disease in the udder, the milk or a piece of udder tissue, extracted by means of an instrument called a harpoon, may be examined bacteriologically.

In tuberculosis of the brain, the animal is unsteady and uncertain in its movements. It lies down a great deal, is usually subject to occasional cramps and is apt to carry the head in an unusual position. Such cases are inclined to progress rapidly and terminate in death following coma or convulsions. In tubercular disease of the bones and joints, these parts are enlarged, there is loss of motion, pain and usually abscess formation followed by the discharge of thick yellow pus. The stifle joint is often enlarged from this cause. In tuberculosis of the uterus or ovaries and sometimes in peritoneal tuberculosis in the cow, the subject is almost continually in heat. In tuberculosis of the uterus, there is sometimes a discharge of thick, yellowish material mixed with mucus and slime. In tuberculosis of the testicles these organs become enlarged and hard.

In all advanced cases the nutrition of the animal is interfered with and, sooner or later, the "tuberculous cachexia" appears. It is, however, in many cases remarkable to note the extent of lesions in animals that are well nourished and present no external signs of

disease. Animals killed in prime condition by the butcher are sometimes found to contain extensive lesions of tuberculosis widely distributed. In widespread or general tugerculosis, many of the symptoms described above may occur simultaneously.

The symptoms of acute tuberculosis.—The course of tuberculosis is usually long, extending over months or even years. Occasionally, however, it is cut short by the rapid form known as acute miliary tuberculosis, which is often referred to when it occurs in man as "galloping consumption." The symptoms of acute miliary tuberculosis are rapid loss of condition, depression, poor appetite, cough, weakness, rapid breathing, harsh respiratory sounds, some elevation of temperature, increased pulse rate and, sometimes, enlarged lymphatic glands. The course of this form of tuberculosis is always rapid and terminates in death. Acute miliary tuberculosis results, as previously stated, when large numbers of tubercle bacilli are discharged into the blood current; they are then carried to all parts of the body, are filtered out in the lungs, liver, spleen, kidneys and elsewhere, setting up tuberculosis in each of these localities. The point at which the infectious material entered the circulation may have been a comparatively small area of disease; perhaps a tubercular lymphatic gland. This form of tuberculosis is more likely to appear in young animals than in adults, and is more common among swine than among cattle.

CHAPTER VIII.

THE RECOGNITION OF TUBERCULOSIS IN LIVING CATTLE AND THE TUBERCULIN TEST.

SUMMARY.

THE SYMPTOMS OF TUBERCULOSIS IN CATTLE ARE AS A RULE NOT SUFFICIENTLY PROMINENT TO ENABLE ONE TO DIAGNOSE THE DISEASE EXCEPTING WHEN THE LESIONS ARE EXTENSIVE, ARE INTERFERING WITH THE FUNCTION OF AN IMPORTANT ORGAN OR ARE CLOSE TO THE SURFACE. AN ANIMAL MAY HAVE TUBERCULOSIS TO A DEGREE THAT RENDERS IT CAPABLE OF SPREADING DISEASE WITHOUT SHOWING PHYSICAL SYMPTOMS.

THE TUBERCULIN TEST FOR TUBERCULOSIS DEPENDS UPON THE FACT THAT WHEN A SMALL QUANTITY OF THE REAGENT TUBERCULIN IS INJECTED BENEATH THE SKIN OF A HEALTHY OR NON-TUBERCULAR ANIMAL NO EFFECT IS PRODUCED, BUT IF THE ANIMAL IS TUBERCULAR A FEBRILE REACTION OCCURS.

TUBERCULIN IS A GLYCERINE EXTRACT FROM CULTURES OF TUBERCLE BACILLI WHICH HAS BEEN FILTERED THROUGH PORCELAIN, STERILIZED AND MIXED WITH A SOLUTION OF CARBOLIC ACID. IT CONTAINS NEITHER LIVING NOR DEAD GERMS OF TUBERCULOSIS AND IS ABSOLUTELY INCAPABLE OF PRODUCING TUBERCULOSIS.

TO GIVE SATISFACTORY RESULTS IT IS NECESSARY THAT TUBERCULIN SHALL BE USED WITH A DUE REGARD FOR CERTAIN RULES BY ONE WHO UNDERSTANDS THE CONDITIONS UNDER WHICH IT MAY BE EMPLOYED ADVANTAGEOUSLY, THE CONDITIONS IN WHICH IT IS CONTRAINDICATED AND THE METHOD OF INTERPRETING THE RESULT OF THE TEST.

THE TUBERCULIN TEST IS NOT INFALLIBLE. IT HAS, HOWEVER, FURNISHED A METHOD FOR RECOGNIZING TUBERCULOSIS THAT IS INCOMPARABLY THE MOST ACCURATE THAT HAS EVER BEEN EMPLOYED.

HERDS REPEATEDLY TESTED WITH TUBERCULIN DURING THE PAST TEN YEARS ARE NOW IN BETTER CONDITION THAN EVER BEFORE AND THERE IS NO REASON TO FEAR THAT THIS REAGENT IS CAPABLE OF INJURING CATTLE IN ANY WAY.

Physical examination insufficient.—By the ordinary methods of physical examination it is only possible to recognize tuberculosis when the diseased parts are extensive and interfere with the function

of an important organ or lie close to the surface. Tuberculosis may exist as a local disease for a long time before general symptoms of illness appear. Indeed, as has been explained in a previous chapter, the disease may sometimes be remarkably extensive without reducing the apparent condition of the animal or interfering with the functions of any of its organs enough to occasion signs of disease. During all but the last part of this period of slow development, the cow containing lesions of tuberculosis may eat well, be in good flesh and condition, have a pliable skin and a smooth, bright coat, rarely cough, produce a full flow of milk and pass almost anywhere for a sound animal. It is not until late that the symptoms described in the previous chapter appear.

Until tuberculin was known it was not possible to recognize early stages of tuberculosis in the living animal, nor was it possible to recognize early cases that were quite advanced. In man, diagnosis is made frequently by the discovery of tubercle bacilli in the sputum. This method has been applied to cows but its results, except in very advanced cases, when it is not needed, are uncertain. If tubercle bacilli are found by this examination, it shows that tuberculosis exists, but if they are not found, it does not signify that the animal may not be diseased to a dangerous degree. The most accurate of the old methods of diagnosis consisted in inoculating experimental animals with the milk or expectorations of the suspected cow, but even here the absence of affirmative results did not prove freedom from disease. moreover from four to six weeks were required for obtaining results by this method. It was therefore a great advance when Koch showed that tuberculin is an extremely delicate reagent for the purpose of revealing the existence of tubercular disease in the living animal.

Tuberculin.—Tuberculin was invented by Koch in 1890, and was first used experimentally as a remedy for tuberculosis. It was observed that whenever tuberculin was administered to a consumptive or tubercular patient the administration was followed by a fever, called a reaction, lasting a few hours or a day. This observation led veterinarians to apply tuberculin to tubercular and suspected cattle for the purpose of determining whether a similar fever or reaction would occur. It was soon found that a small quantity of tuberculin injected beneath the skin of a tubercular cow would, with remarkable regularity, cause a febrile reaction; whereas, no change was produced in animals that were not afflicted with tuberculosis or were suffering with some other disease.

Since 1891 the use of tuberculin for testing cattle to determine the presence or absence of tuberculosis has grown at a rapid rate in all parts of the world. It has not been found, and has never been claimed, that tuberculin is an infallible diagnostic agent. It has, how-

ever, been shown conclusively that tuberculin has increased the power to recognize tuberculosis many fold and furnishes results that are immeasurably more accurate than those obtained by the use of any other agent or method that has ever been employed or proposed. Objections to the use of tuberculin have been made from time to time and are considered below. It can be safely said that so far as alleged injury to a healthy animal is concerned, no fear need be entertained, but this matter is considered in greater detail elsewhere and the reader is referred to the reports of herd owners whose cattle have been tested with tuberculin (See appendix to Chapter X).

THE TUBERCULIN TEST.

The following is a copy of a circular issued by the State Live Stock Sanitary Board and contains the instructions given to inspectors employed by this Board:

"CIRCULAR NO. 1.

Directions for Inspecting Herds for Tuberculosis.

"It is necessary that a certain uniformity shall be observed by those who inspect herds for the State Live Stock Sanitary Board and, while it is not desired to interfere in any way with approved individual methods, the following plan is recommended to all inspectors:

"The herd should be stabled while the inspection is being made, although this is not absolutely essential in warm weather, if the cattle can be tied or kept quietly in a small paddock. If it is necessary to stable animals under unusual conditions or among unusual surroundings that make them uneasy and excited, the tuberculin test should be postponed until the cattle have become accustomed to the conditions to which they are subjected.

"The herd should be fed and watered as usual during the test, excepting in winter, the animal must not be allowed to drink freely of cold water less than two hours before temperature measurements.

"The inspection should begin with a careful physical examination of each animal. This is essential because in some advanced cases of tuberculosis no reaction follows the injection of tuberculin, but experience has shown that these cases can be discovered by physical examination. This examination should be complete and include a careful examination of the udder and of the superficial lymphatic glands and auscultation of the lungs.

"Each animal should be numbered or described in such a way that it can be recognized without difficulty. It is well to number the

stalls with chalk and transfer these numbers to the temperature sheet so that the temperature of each individual can be recorded in its appropriate place without danger of confusion. The following procedure has been used extensively and has given excellent results:

"1. Take the temperature of each animal to be tested at least twice at intervals of three hours, before tuberculin is injected.

"2. Inject the tuberculin in the evening, preferably between the hours of 6 and 9. The injection should be made with a carefully sterilized hypodermic syringe. The dose should be graduated accurately. The most convenient point for injection is back of the left scapula.

"Prior to the injection, the skin should be carefully washed with a 5 per cent. solution of creolin or with some other antiseptic.

"3. The temperature should be taken nine hours after the injection, and temperature measurements repeated at regular intervals of two or three hours until the sixteenth hour after the injection.

"4. Where there is no elevation of temperature at this time (sixteen hours after injection), the examination may be discontinued; but if the temperature shows an upward tendency, measurements must be continued until a distinct reaction is recognized, or until the temperature begins to fall.

"5. If a reaction is detected prior to the sixteenth hour, the measurements of temperature should be continued until the expiration of this period.

"6. The thermometers used for this work must be accurate, and if several are used, they should be compared before the examination is commenced.

"7. If there is an unusual change of temperature in the stable or a sudden change of weather, this fact should be recorded on the report blank.

"8. If a cow is in a febrile condition when the initial temperatures are taken, tuberculin should not be used on her, because in this case the temperature curve is irregular and the result of the test uncertain.

"9. The tuberculin test is not recommended for calves under three months old.

"10. In old, emaciated animals and in retests, use twice the usual dose of tuberculin, or more, according to the conditions.

"In reporting upon the examination of the herd, the large temperature sheets should be filled out and returned, together with a more detailed record for each animal that proves to be tubercular. This detailed report should be made out on the individual report blanks provided for this purpose, but is not necessary for cattle that are sound.

"Each cow that proves to be tubercular should be appraised either by agreement between the inspector and the owner or, when a just, fair and legal agreement can not be made, by three sworn appraisers appointed in accordance with the act of May 21, 1895. This law provides that in appraising, the actual value and condition of the animal at the time of appraisement shall be taken into consideration, and this provision must not be lost sight of.

"The records of the examination of the cattle and premises and the appraisement of the tubercular animals should all be forwarded to the State Veterinarian at the same time and as soon as possible after the inspection has been completed, after which, advice in reference to the disposition of the condemned animals will be sent to the inspector.

"In special cases, inspectors may be directed to destroy and take post-mortem examinations upon the condemned animals as soon as they are recognized, but this must be done only when directions to this effect are given in the original letter of advice.

"Condemned cattle must be removed from the herd and kept away from those that are healthy.

"In making post-mortems, the carcasses should be thoroughly inspected, and all of the organs mentioned on the blank for reporting this work, should be examined. The extent of the disease in the various organs should also be indicated.

"After the completion of the inspection and the removal of the diseased animals from the herd, the buildings and surroundings must be very thoroughly disinfected in accordance with the special instruction for this work contained in Circular No. 2. This must not be overlooked in any case, and must be carried out with close attention to details. The owner of the herd agrees to do this at his own expense, as one of the conditions upon which the examination is made. The inspector is, however, expected to furnish full instructions regarding it and to know that the work is thoroughly performed.

"Leonard Pearson,
State Veterinarian."

The method of interpreting the result obtained by the test, differs under different examiners.

The directions issued from the research laboratory of the Royal Veterinary College by McFadyean advise that "Animals in which the temperature during the fifteen hours following injection, rises *gradually* to 104° F. or more, may be classed as tubercular. When those in which it remains under 103° F. as not tubercular. When the maximum temperature attained is under 104° but over 103° F., the case must be considered doubtful, and the animal may be retested after a month."

In Germany, the official regulations from the Minister of Agriculture issued in 1896 state that: "If one compares the highest temperature before the injection with the highest temperature after the injection the following is to be noted in regard to the difference between them:

"A. If this difference equals 1.5° C. or more, the existence of tuberculosis is to be assumed.

"B. If the difference is less than 1.5° C. it is probable that the animal is free from tuberculosis."

Instructions issued from the same source on October 29th, 1900, advise as follows:

"A. Cattle are to be regarded as having reacted when their temperature before injection of tuberculin does not exceed 39.5° C. but does exceed 39.5° C. after injection, and when the difference between the highest temperatures before and after injection is more than 1° C."

"B. In the case of calves up to the age of six months, a rise in temperature following the injection of tuberculin, to above 40° C. and at least 1° C. above the highest temperature before inspection, is to be regarded as a reaction."

Similar systems are followed in Belgium and France, with the exception that a rise of 1.4° C. is looked upon as a reaction indicating the existence of tuberculosis; while if the highest temperature after injection is less than 1.4° C. above the highest temperature before injection, the animal is considered free from tuberculosis.

The Swiss method differs materially from those mentioned, in that while a rise of 1.5° C. is regarded as a reaction and indicative of the existence of tuberculosis, the animal is not considered free from tuberculosis if there is a rise of temperature following the injection of tuberculin exceeding 0.5° C. and, therefore, the animals that show a rise of between 0.5° and 1.5° C. are considered doubtful. By this method of interpreting the tuberculin test a great many cattle that would be passed as sound or condemned in other countries, are marked doubtful in Switzerland.

In Denmark the tendency has been to refrain from fixing a definite standard for reactions. The temperature curve following injection is there compared with the temperature measurements made prior to the injection of tuberculin, and the character of the curve, as well as its altitude is given consideration. A rise of temperature exceeding 40° C. continuing for several hours and occurring within the limits of time during which experience has taught that a reaction may be expected, is sufficient to lead to the condemnation of the animal. If there is doubt as to whether a certain temperature curve is a reaction, the central authorities are conferred with and sometimes a retest is made.

Eber, of Dresden, in his excellent little book on "The Tuberculin Test and the Suppression of Tuberculosis of Cattle," has described a method of interpreting tuberculin tests that has given remarkably accurate results in his hands. He divides reactions into four groups and instructs as follows:

First. In all cattle with temperatures not exceeding 39.5° C. before the injection, an elevation of temperature after injection to 40° C. and above, is to be regarded as a reaction.

Second. If the highest temperature after injection lies between 39.5° and 40° C. this is to be regarded as a reaction, provided this temperature is at least 1° C. above the highest temperature before injection.

Third. Doubtful reactions are those in which the highest temperature following injection lies between 39.5° and 40° C. and is from 0.5° C. to not more than 1° C. above the highest temperature before injection.

Fourth. Where the temperature after injection does not exceed 39.5° C., or if it exceeds 39.5° C. but is not more than 0.5° C. above the original temperature, the animal may be regarded as free from tuberculosis.

Eber reports 78 reacting animals that were judged according to this method and were slaughtered. In each case the lesions of tuberculosis were found. Ten that did not react were killed and found to be free from tuberculosis. In two animals the result of the test was doubtful. One of these showed well marked symptoms of tuberculosis during life and lesions of tuberculosis were found, as expected, upon post-mortem examination. The other animal did not present symptoms of tuberculosis and upon slaughter no lesions of tuberculosis were found. In testing 571 cattle, of which 439 reacted and 118 did not react, only 14, or $2\frac{1}{2}$ per cent., had temperature curves that could not be classified as reaction or no reaction and had to be regarded as doubtful according to the third part of the scheme.

One of the advantages of Eber's method as compared with the official English, Prussian and French methods, lies in the fact that many cases of very advanced tuberculosis do not respond to the tuberculin test and thus with a rigid standard, some of the worst cases of tuberculosis might be passed as sound. It should be stated, however, that McFadyean calls attention to the fact that the test is not reliable in the last stages of the disease, or in those in which the temperature is above 103° F. before injection.

Hutyra has recently published a system that he has developed for interpreting the result of the test. He says: "Every animal is to be regarded as tubercular (a) when the temperature after injection rises, in a way that is typical of reaction, 1.5° C. or more above the temperature before injection, or to above 40° C. and at least 0.5° C.,

and (b) when the temperature rises from 1° C. to 1.4° C. and there is an organic reaction. The organic reaction is expressed by muscular tremors.

"On the other hand, there is no reason to regard an animal as tubercular if the temperature rise does not exceed 1.4° C. nor the absolute temperature does not exceed 39.5° C., if there is no organic reaction, and if no evidence of tuberculosis is revealed by a systematic physical examination."

In Pennsylvania, we do not have an inflexible method of interpreting the tuberculin test. In general, however, a rise of 1.5° F. or more above the previously established normal, and to above 103° F., within from eight to sixteen hours after the administration of tuberculin, and the continuance of this elevation for at least three hours, is looked upon as a reaction when no cause of fever is evident except the injected tuberculin and where all of the necessary precautions have been observed.

In averaging the results of 700 positive tests, it is found that the usual time for the maximum reaction is 14 hours after injection of tuberculin, and the average rise is 4.1° F. above the previously established normal.

In addition to the reaction as indicated by the rise of temperature, some authors have called attention to a swelling at the point of injection which they regard as of diagnostic importance. It is sometimes observed that a hot, painful swelling appears about twelve hours after injection and continues for one day. It is not believed, however, that this swelling, which is by no means constant, is of diagnostic significance, because in many tests of herds it is not seen at all and it sometimes occurs in cattle that do not respond to tuberculin by rise of temperature. Indeed, it is highly probable that this swelling, if it is large, is usually due to uncleanliness on the part of the operator and to imperfect sterilization of the syringe.

The beginning of the reaction is sometimes marked by a chill in which the coat rises, the animal stands in a contracted position and exhibits some trembling of the superficial muscles. Where the chill is marked, the reaction is characterized by a great rise of temperature. Chills are not common. Some cows undergoing the tuberculin test develop more or less well marked diarrhoea, accompanied, usually, by loss of appetite. It has been shown in a number of cases that this manifestation is accompanied by well marked lesions in the abdominal cavity.

The effect of tuberculin on the flow of milk is immaterial, if there is no reaction. In the last test of the herd belonging to the Pennsylvania State College Experiment Station, 27 cows were giving milk and all of them were found to be free from tuberculosis. The shrinkage was less than 1 per cent. and this was ascribed to the fact that

the cows were disturbed during the night when their temperatures were taken. This shrinkage was less than the normal variation on some days. The proportion of butter fat was unchanged. Where cows are tubercular and respond actively to the test,there is a greater influence on milk production. Sometimes, when the temperature is high, the shrinkage amounts to 15 or even 20 per cent., but the normal flow is re-established in two or three days.

The actual lesions of tuberculosis are surrounded by a hyperaemic zone during the period of reaction.

The effect of Tuberculin on healthy cattle.—It is explained in another part of this bulletin that tuberculin is a sterile fluid holding certain substances in solution. It cannot cause tuberculosis.

The question as to whether repeated injections of tuberculin may injure an animal has been settled by the researches of Law (Bulletin on the Effect of Tuberculin on Healthy Cows, Cornell University Agricultural Experiment Station), who has shown that healthy animals are not injured by repeated injections of this agent. The reports of the numerous herd owners that are contained in the Appendix to Chapter X are further proof in this direction. The largest and best herds in Pennsylvania have been tested. It is not claimed by a single one of these reporters that his cattle have been injured by tuberculin and there are numerous reports to the effect that the cows have done better since the test than ever before.

In Pittsburg about 8,000 cows have been tested at the stock yards since January, 1898. Most of these cows were advanced in pregnancy or had freshly calved. Some of them calved during the time that the test was being made. None of these cows was injured by the test. Indeed they do better; they calve and clean better and milk better than before, but this is probably due to the fact that they now have more attention. At any rate, there is in Pittsburg no room or inclination to ascribe any unfavorable results to the test.

Herds that were tested six or seven years ago and have been retested at intervals, are sound and thrifty to-day. In the two largest dairy herds in the East (each one has about 600 cows) all cows purchased are tested before they are added to the herds. This practice has been going on for several years. There is not one case in either herd in which it appears that a single animal has been injured in the least.

In Pennsylvania, the greatest number of tests are voluntarily applied for in parts of the State, where the greatest number have already been made; that is, where the effects of tuberculin are best understood. This would not be possible if tuberculin were in any way injurious.

Numerous agricultural experiment station herds have been tested

with tuberculin, notably that at the Pennsylvania State College where the first test was made in June and July, 1892. Since that time the cattle have been tested three times and have been under very close observation and there is no reason to suspect that the slightest injury has resulted from testing them. The herd is in fine condition and quite free from tuberculosis at this time, as it has been ever since the first test.

The effect of tuberculin on tubercular cattle.—It was once feared that tuberculin might cause chronic lesions to blaze into activity. At the International Veterinary Congress held in Berne in 1895, this opinion was advanced by Hess. The subject was then thoroughly discussed by Bang, Nocard, Hutyra, Malm, Siedamgrotzky and others, with the result that Hess' view was not sustained. In Pennsylvania, reacting cattle have not been kept alive for a very long time, usually not more than a few days, in a few cases several weeks, but in no instance has it been observed that the disease was stimulated into acute activity. Nocard reports that under 3,500 tests, he has observed but three in which he was able to discover any indication that the disease (in an already diseased animal) followed a more rapid course as a result of the use of tuberculin. In Denmark, thousands and thousands of cattle have been tested and have been kept alive, some of them for years. It has not been observed there that the disease follows a more rapid course after the injection of tuberculin. There is ample justification for the statement that such an effect need not be feared. Indeed, there are numerous observations, some of them made at the Veterinary Department of the University of Pennsylvania, and others based upon experiments conducted under the auspices of the State Live Stock Sanitary Board, which show that in many cases the disease is actually retarded by the use of tuberculin and that tuberculin in some cases has a certain remedial effect.

Precautions.—In testing cattle there are numerous precautions to observe. If these are disregarded the test will result in disappointment. Some of these requirements are noted in the instructions for making the tuberculin test that are given above, the most important of them are: Reliable tuberculin, sterile syringe, accurate thermometer, avoidance of conditions that will excite the animals under test. absence of febrile condition and accuracy of temperature measurements. To these must be added a very careful physical examination, because, as has been stated elsewhere, animals that are extensively diseased with tuberculosis and to such an extent that it is revealed by physical examination do not always respond to the tuberculin test. This is probably because they have developed a resistance to the action of tuberculin through the continued action of the products of the tubercle bacilli in their bodies. Their resistance is

comparable to the resistance that is occasionally observed when retesting animals that have been subjected to the tuberculin test one or more times.

It was formerly supposed that cows heavy with calf are not suitable subjects for the test, and it was further believed that some pregnant cows that were not tubercular would respond to the tuberculin test on account of their delicate condition. During the past three years about 50,000 dairy cows coming into Pennsylvania from other states have been tested and reported upon to the State Veterinarian. Many of these cows are "springers" and due to calve within a few weeks or a few days after the test. Others are fresh cows. Several hundred of them have calved during the time that the test was being made. It has not been observed in any of these cases that there is an increased sensitiveness to tuberculin. Indeed, only a small percentage of them has reacted at all. This view is supported by the Danish observations and by the statement of Eber, who says that he has tested cows that have calved within twenty-four hours of the injection of the tuberculin, that the tuberculin has not injured the cow or the calf and his belief is that "advanced gestation of an animal to be tested with normal conditions otherwise, does not constitute an obstacle to the tuberculin test. It is only when the temperature materially exceeds 39.5° C., or when there is dyspnoea on account of pregnancy that the test should be deferred until the temperature falls to normal or parturition occurs."

Accuracy of Tuberculin.—As to the value of the tuberculin test from the standpoint of accuracy, it is instructive to compare the results obtained by it with those obtained from physical examination made by those who are most expert in this work. We then appreciate its immeasurable superiority and high value. It has never been claimed, and is not now claimed, that tuberculin is infallible. Some conditions over which we have no control and some conditions that are not as yet fully understood, operate against it.

In 1899, Voges gathered all published statistics showing tuberculin tests that had been controlled by post-mortem examination. He found that of 7,327 animals that had been tested and subsequently examined post-mortem, wrong diagnoses were made in 204; that is, in 2.78 per cent. This is a distinct improvement over the statistics that were published by Eber in February, 1892, in which it was shown that inaccurate results were obtained in about 13 per cent. of all cases. As experience with tuberculin accumulates, still better results will, no doubt, be obtained.

In the work of the State Live Stock Sanitary Board, covering about 4,400 post-mortem examinations of reacting cattle, the lesions of tuberculosis have been found in all but eight animals that have reacted in a way that was deemed characteristic. We are not, how-

ever, justified in saying that tubercular lesions did not exist in these animals because every portion of the carcass could not be examined. It can only be said that they were not found.

As to the number of failures that have been made on the other side, that is, the number of tubercular cows that have not responded to the tuberculin test, we have no accurate data because very few of them are killed until after a long time and even of these very few are subjected to post-mortem examination.

There is proof, however, that a variable, but small percentage of tubercular cattle fail to react. It is for this reason that badly infected herds should be retested and is advised in another place. In Europe a great many tested cattle have been killed and the opinion there, as expressed by the Sixth International Veterinary Congress (1895), is as follows: "Tuberculin is a very valuable diagnostic agent and can be of the greatest value in combatting tuberculosis. There is no reason to refrain from the use of tuberculin through fear that it will hasten the development of existing disease." At the Seventh Congress held in Baden-Baden in 1899, it was resolved, * * * "The best means thus far discovered for the prevention of tuberculosis is tuberculin."

A committee of the Royal Agricultural Society of England has recently studied this question in a most careful way and has conducted a number of investigations to secure further facts to aid in elucidating it. The report of this committee (December, 1900,) ends with the following words: "Even when full account is taken of these possibilities of error, the committee are of opinion that tuberculin is an agent of great value, far surpassing all other methods of diagnosis, and that, if properly employed, it is calculated to render immense service in dealing with tuberculosis."

No one doubts that tuberculin furnishes incomparably the best means of diagnosing tuberculosis of cattle and, therefore, it furnishes the best means for separating cattle that are tubercular from those that are healthy. It is always necessary, however, to use the test skilfully and to supplement it by careful physical examination.

CHAPTER IX.

THE PREVENTION AND SUPPRESSION OF TUBERCULOSIS OF CATTLE.

SUMMARY.

IT IS OF HIGH IMPORTANCE TO THE WELFARE OF THE LIVE-STOCK OWNERS AND TO THE CONSUMERS OF MILK THAT TUBERCULOSIS OF CATTLE SHALL BE SUPPRESSED. WHETHER THIS MATTER IS OF MORE IMPORTANCE TO AGRICULTURE THAN IT IS IN THE CAUSE OF PUBLIC HEALTH, DEPENDS UPON WHETHER THE PUBLIC IS ALREADY PROTECTED BY EFFICIENT MILK AND MEAT INSPECTION.

THE VARIOUS MEASURES THAT MAY BE APPLIED BY CATTLE OWNERS TO RID HERDS OF TUBERCULOSIS MAY BE CLASSED UNDER FOUR HEADS, AS FOLLOWS:

1. THE SUPPRESSION OF TUBERCULOSIS BY IMPROVED AND SALUBRIOUS CONDITIONS OF LIFE. THAT IS, THE SUPPRESSION BY GOOD SANITARY CONDITIONS ALONE. UNFORTUNATELY, AS MANY MEN HAVE FOUND TO THEIR SORROW, NO STABLING CONDITIONS CAN BE GOOD ENOUGH TO ENTIRELY PREVENT THE SPREAD OF TUBERCULOSIS IN AN INFECTED HERD. TUBERCULOSIS WILL SPREAD, ALTHOUGH LESS RAPIDLY THAN UNDER WORSE CONDITIONS, IN THE BEST CONSTRUCTED AND APPOINTED STABLE, AMONG ANIMALS CARED FOR IN THE BEST WAY, IF PART OF THEM ARE TUBERCULAR. THIS METHOD OF SUPPRESSION IS RECOMMENDED BY PEOPLE WHO HAVE LITTLE PRACTICAL KNOWLEDGE OF TUBERCULOSIS; IT IS NOT PRACTICABLE IN THE EAST NOR FOR DAIRY FARMERS—NOR IS IT SAFE TO RELY UPON IT ANYWHERE.

2. THE SUPPRESSION OF TUBERCULOSIS BY GOOD SANITARY CONDITIONS, ACCOMPANIED BY REMOVAL FROM THE HERD OF ALL ANIMALS PRESENTING PHYSICAL SIGNS OF DISEASE. THIS METHOD NECESSITATES GOOD STABLING CONDITIONS, GOOD CARE AND FREQUENT INSPECTION BY A SKILLED VETERINARIAN FOR THE PURPOSE OF REMOVING ANY ANIMALS THAT SHOW THE EARLIEST SIGNS OF TUBERCULOSIS. BY THIS METHOD EVERY ANIMAL THAT DEVELOPS TUBERCULOSIS TO A CERTAIN DEGREE, WILL BE REMOVED. HENCE, EVERY INFECTED ANIMAL THAT IS IN THE HERD AT THE BEGINNING OF THE APPLICATION OF THIS METHOD OF SUPPRESSION, WILL, IN TIME, BE REMOVED; BUT THERE WILL ALWAYS BE CASES ADVANCED ENOUGH TO SPREAD SOME DISEASE AND, IN MOST INSTANCES, TUBERCULOSIS CANNOT BE WHOLLY ERADICATED FROM A HERD BY THIS METHOD. THIS METHOD IS SUCCESSFUL WHEN THE STABLING AND SANITARY CONDITIONS ARE EXCEPTIONALLY GOOD AND WHERE THE SERVICES OF AN ESPECIALLY SKILLFUL VETERINARIAN ARE FREELY AVAILABLE. SO LONG AS THIS METHOD WAS RELIED ON, TUBERCULOSIS SPREAD RAPIDLY IN ALL PARTS OF THE WORLD THAT IT HAD REACHED.

3. THE SUPPRESSION OF TUBERCULOSIS BY THE REMOVAL OF TUBERCULAR ANIMALS AS DETECTED BY PHYSICAL EXAMINATION AND BY THE TUBERCULIN TEST. BY THIS METHOD ALL ANIMALS WITH TUBERCULOSIS CAN BE REMOVED FROM CONTACT WITH HEALTHY ANIMALS AND THE PROGRESS OF DISEASE CAN BE CHECKED COMPLETELY AND QUICKLY. IT IS THIS METHOD THAT IS GENERALLY FOLLOWED IN THE VARIOUS COUNTRIES OF EUROPE AND IN DIFFERENT STATES OF THIS COUNTRY WHERE SUCCESSFUL WORK IS BEING ACCOMPLISHED. THE REMOVAL OF THE TUBERCULAR CATTLE IS FOLLOWED BY DISINFECTION AND IMPROVED SANITATION.

THE BANG OR DANISH SYSTEM COMES UNDER THIS HEADING AND SO DOES THE PENNSYLANIA PLAN.

4. THE SUPPRESSION OF TUBERCULOSIS BY QUARANTINING INFECTED AND EXPOSED CATTLE AND BY REARING THEIR PROGENCY AS A SEPARATE HERD. THIS METHOD MAKES IT NECESSARY TO REGARD AND TREAT ALL OF THE OLDER CATTLE OF AN INFECTED HERD AS THOUGH THEY WERE TUBERCULAR.

THESE CATTLE ARE KEPT APART FROM OTHER CATTLE. THE YOUNG ANIMALS IN THE HERD ARE TESTED AND ALL THAT ARE TUBERCULAR ARE PLACED WITH THE OLDER CATTLE WHILE THOSE THAT ARE SOUND ARE KEPT IN A SEPARATE PLACE, AWAY FROM THE QUARANTINED HERD AND AWAY FROM THE POSSIBILITYOF INFECTION BY THEM. THE CALVES BORN OF THE COWS IN THE QUARANTINED HERD ARE TO BE REMOVED AT ONCE AFTER BIRTH AND FED ON MILK FROM HEALTHY COWS OR ON HEATED MILK FROM SUSPECTED COWS. IN THIS WAY A NEW SOUND HERD IS GROWN TO TAKE THE PLACE OF THE OLD HERD WHICH WILL IN TIME DIE OFF, AND TUBERCULOSIS WITH IT.

"OWNERS OF CATTLE OUGHT TO PREVENT THE CONTAMINATION OF CALVES AND OTHER ANIMALS STILL HEALTHY."—BANG.

THE PUBLIC MEASURES TO SUPPRESS TUBERCULOSIS ARE (1) COMPULSORY, (2) VOLUNTARY AND (3) PARTLY COMPULSORY AND PARTLY VOLUNTARY.

THE METHODS THAT DEPEND LARGELY UPON THE CO-OPERATION OF THE HERD OWNER ARE THE MOST SUCCESSFUL.

Importance.—The importance of suppressing tuberculosis of cattle is very great, both on account of the losses that are occasioned by this disease and because it constitutes a constant menace to the public health.

The measures that have been directed against tuberculosis of cattle in different parts of the world have been based upon one or both of these grounds. In some places one reason is the more important, in other places the other. For example, in Germany where it is the almost universal practice to heat or boil milk before using it and where practically all of the slaughter houses are subject to veterinary control and dangerous meat is not permitted to reach the market, the public is subjected to little risk on account of the prevalence

of tuberculosis among cattle; so that in that country, with its well developed sanitary cordon to protect consumers from injury by the products of tubercular animals, this subject is almost purely agricultural. In England, on the other hand, where meat inspection is in its infancy and is practiced efficiently in but few places, tuberculosis of cattle, as is shown by the reports of the two Royal Commissioners on Tuberculosis, is of much importance in relation to the public health.

In most places in this country, the importance of the disease is two-fold, although in Massachusetts, in part of Minnesota, in the District of Columbia, and in some other places where meat inspection and dairy inspection are practiced, these inspections serve to remove most of the jeopardy to which the public is exposed in other places where tuberculosis prevails extensively among cattle.

In Pennsylvania there is no meat inspection at slaughter houses outside of Philadelphia and it is not complete in that city. A number of towns require milk producers to exhibit certificates showing that their herds are free from tuberculosis and in these localities the losses caused by tuberculosis of cattle are principally agricultural. In other places the question of public health is involved.

Whatever barriers may be erected to protect the public from tuberculosis in meat and in milk, there can be no doubt that the most efficient protection and, in the end, the cheapest, may be obtained by suppressing the disease in herds.

MEASURES THAT MAY BE APPLIED BY CATTLE OWNERS TO RID HERDS OF TUBERCULOSIS.

Without the most thorough system of sanitary police as applied to domestic animals and the enforcement of rigorous and arbitrary methods, all of which would cost enormous sums of money and be exceedingly obnoxious to herd owners, tuberculosis cannot be eradicated from infected herds by State officers, if they fail to secure the co-operation of the herd owners themselves. In other words, if tuberculosis is to be suppressed without too much expense, either to the State or to the owner of the cattle and without the use of burdensome measures, it must be done by co-operation of the farmers and the agents of the Commonwealth.

First of all, general principles to be observed in suppressing tuberculosis should be established. Then, measures based upon these principles should be formulated and herd owners should be assisted in enforcing them. The methods that have been suggested or employed for the eradication of tuberculosis from infected herds are considered in the following parts of this chapter. These are regarded first from the standpoint of the herd owner and afterwards

from that of the State. The methods that have been tried will be mentioned separately and some of the general measures that must enter into each of them will be discussed.

The following are the principal methods that have been suggested or employed for suppressing tuberculosis in herds:

1. *The suppression of Tuberculosis by improved and salubrious conditions of life.*

By this method I refer to the suppression of tuberculosis by good sanitary conditions alone. If an infected herd can be kept under such very good conditions that the progress of the disease is not so rapid as the natural increase of the herd, tuberculosis may, in time, die out. For example: If 15 per cent. of the members of a herd of 100 cattle are afflicted with tuberculosis and the conditions of life are so good that it spreads to but 15 per cent. of the unifected animals each year, and the herd is changed each year by the addition to it and removal from it of 40 per cent. of its number, it will be seen that the healthy animals are increasing at a more rapid rate than the tubercular ones, so that, at length, the disease will disappear.

The employment of the methods of care and management that are known to restrict the spread of tuberculosis in the herd, by preventing the distribution and accumulation of infectious germs in the stable and by placing cattle in a comparatively resistant condition, will do much to check the progress of this disease. Indeed, some writers have gone so far as to intimate, or claim, that tuberculosis can be controlled sufficiently by the use of sanitary precautions alone. These claims are, however, in direct opposition to the results of careful observation that have been made by competent observers in nearly all of the civilized countries of the world. It is certain that tuberculosis cannot be eradicated solely by any conditions of stable management, feeding or care that can be generally practiced upon dairy herds, so long as tubercular cattle are permitted to associate or remain in the stable with those that are healthy.*

Tuberculosis may spread, although usually slowly, among cattle at pasture. (See page 40.) It has, in many instances, been found to be very prevalent in stables of the best construction and among cattle cared for in a very much better way than is generally possible. While it is true that the rate of progress may be retarded by desirable conditions, these conditions cannot, in general farm practice, be good enough to retard the progress of tuberculosis to such an extent as to cause it to disappear from the herd. This, however, is no argument against good conditions. These should, in all cases, be as

*See account of experiment conducted by the State Live Stock Sanitary Board, in which tubercular and healthy cattle were kept in a sanitary stable under the best possible care. Published as a separate Bulletin, No. 74.

good as they can be made and dairymen will derive numerous advantages from whatever improved sanitary conditions they may adopt; but it is too much to expect such conditions to lead to the eradication of tuberculosis from an infected herd.

To suppress tuberculosis by this method requires almost continuous out-door life in a favorable climate. This is possible, and is practiced with beef cattle and upon ranches and large farms of the west; it cannot be practiced with dairy cattle in Pennsylvania.

2. *The suppression of Tuberculosis by good sanitary conditions, accompanied by the removal from the herd of all animals presenting physical signs of disease.*

This method of suppression implies the maintenance of a herd under the best sanitary conditions that are in harmony with the purpose for which the herd is kept and the immediate removal of all animals showing symptoms of tuberculosis. In the case of the dairy herd, it means that it must be kept in thoroughly clean, light, well ventilated and comfortable stables. Each cow must be provided with her own stall and individual watering place. The cattle are to be fed in such a way as to keep them in good condition and impart to them the greatest possible vigor. It is necessary to allow plenty of exercise out of doors, to groom them, to disinfect the stable at regular and frequent intervals. Moreover, it is necessary for the herd to be subjected to frequent physical examination and for the owner to submit to the instant removal of every animal presenting symptoms of tuberculosis.

The success of this method is in proportion to the value and appropriateness of the sanitary conditions to which the animals are subjected and the thoroughness and skill with which they are examined by the veterinarian. Where the conditions of stable and of herd management are ideal and a careful physical examination is made at short intervals by a veterinarian of large experience and skill, it is possible, in time, to suppress tuberculosis in a herd by this method. This has been demonstrated by Professor Law at Cornell University and at Ovid, New York.

At the same time, this is not a practical method of suppression for general application because, in the first place, the general herd conditions are not good enough and, secondly, the vast amount of expert care that is required is not generally available.

It should be observed that under this method the herd owner is obliged to lose the tubercular cows that are in his herd at the beginning of the enforcement of measures for suppression and, in addition, he will lose the cattle that are contaminated by them, so that the total losses will be considerably greater than in the case where all of the tubercular cattle are taken out of the herd at one time. In this

case, instead of paying a ransom to tuberculosis in a lump sum and receiving a quit-claim, tribute is paid in instalments and with interest.

This method of suppressing tuberculosis is the one upon which dependence was placed prior to the invention of the tuberculin test. It was enforced in many places with extreme care and under conditions that seemed to be excellent, but without satisfactory results. The inefficiency of this method for general application is shown clearly by the fact that so long as it was relied upon, tuberculosis of cattle increased in all parts of the world that it had reached, and at a rapid rate.

3. *The suppression of Tuberculosis by the removal of tubercular animals as detected by physical examination and the tuberculin test.*

This method of suppression is the one that is now most extensively employed by the government of Europe and it is upon this method, also, that nearly all of the public work directed against the suppression of tuberculosis in the United States is based. It has been shown that it is not possible by means of physical examination to detect any but advanced cases of tuberculosis, and only a fraction of these. None of the early cases nor those that are advanced but do not show physical symptoms, are revealed by physical examination, and these continue to sow the seeds of disease. By testing herds with tuberculin and examining them physically at the same time, the diseased animals can usually be isolated from those that are sound and then, if the sound cattle are kept away from distributors of tubercle bacilli, they remain healthy.

Thorough disinfection of premises occupied by tubercular cattle before they are used for the shelter of healthy cattle, is a necessary part of this method.

It is by this plan that the prevalence of tuberculosis in Denmark has been reduced from 40 to 23.9 per cent., and it is also under it that the results in Pennsylvania have been obtained. This is the method by which tuberculosis has been completely eradicated from a vast number of badly infected herds in every state and country. It is the only method of suppression yet tried on a large scale in different parts of the world, with encouraging results.

The principle of this method is exceedingly simple: The herd is tested with tuberculin; it is then divided into two parts, the reacting section and the sound section. These two sections are kept entirely apart. The reacting cows may be killed or not, according to the local conditions or regulations under which the method is practiced, but at all events they are kept entirely apart from the cattle that are sound. The sound cattle are then re-tested, if the infection in

the herd is extensive, after an interval of from six months to a year, and they may be tested again or not, depending on the result of this test.

The efficiency of this plan depends, first, upon the accuracy with which tuberculin points out the existence of tuberculosis in infected animals, and, second, upon the thoroughness of isolation.

If tuberculin were an infallible diagnostic, this method would be more valuable than it is. Tuberculin cannot be depended upon in every case; but increased experience with it is leading to increased accuracy, and as greater accuracy in diagnosis is attained, the value of this method is increased in the same proportion. Since the latest authentic statistics on the use of tuberculin show that it leads to accurate results in from 97 to 98 per cent. of the animals tested with it, and since not more than 20 per cent. of the tubercular cattle in a herd can be picked out by physical examination, it will be seen that in one case the proportion of error is about 2½ per cent., whereas in the other case it is about 80 per cent.

As to the second point—the thoroughness with which the tubercular cattle are isolated—this is an exceedingly important matter as it is the practice of keeping tubercular animals alive. If possible, they should be kept in separate buildings and cared for by separate attendants. If this cannot be done, a tight and solid partition should separate the tubercular from the healthy animals and there should be no internal communication between these apartments.

The calves from the reacting cattle, with the exception of a few (about 3 per cent.), that are born tubercular, can be reared and will develop healthy animals if they are protected from contamination. These calves must be removed from the dams not later than the second day after they are dropped, and fed on milk that has been pasteurized or on milk from non-reacting cows. When they are a few months old and before they mingle with the general herd, they should be tested to positively establish their freedom from tuberculosis. In this way, the healthy section is increased as the reacting and tubercular section diminishes until, finally, only healthy cows remain.

To properly execute this method after the Danish system, by keeping and using the reacting cattle, requires labor and care. In Pennsylvania, herd owners usually prefer to avoid this extra effort by promptly slaughtering the reacting animals.

4. The suppression of Tuberculosis by quarantining infected and exposed cattle and by rearing their progeny as a separate herd.

Under this method tuberculosis is suppressed by a passive rather than by an active process. The disease is not stamped out; it is allowed to die out.

When this system is practiced, the older cattle in infected herds are not tested at all. All of them being regarded as infected or suspected. They may be examined physically and the clinical or visible cases removed. The young cattle, however, are tested with tuberculin, and those that respond, or are doubtful in any way, are placed with the older cattle, all of which are treated as infected animals. The non-reacting young cattle are kept in a separate herd, maintained in separate enclosures and stables. The calves are removed from the cows soon after birth and are fed only sterilized milk. These calves are tested when they are three or four months old and if they do not react they are placed with the healthy young cattle. If they do react, they are killed. In this way, a new herd of young cattle is developed and the old herd is allowed to gradually expire.

This plan is, no doubt, an efficient one and has yielded satisfactory results in a few cases. With a few modifications it can be carried out by the herd owner with little immediate loss.

If the owner of an infected herd wishes to apply this method for the relief of his own cattle, he should start by removing all calves from their dams as soon as dropped or not later than the second day. These calves should be fed upon sterilized milk and kept entirely apart from the rest of the herd in untainted quarters. Indeed, the greater the distance that separates them the better, and they should be cared for by an attendant who has nothing to do with the infected animals. As calves accumulate and mature, the nucleus of a young herd is formed. Nothing is added to the old herd and it will in time die out, while the young herd will increase and, at length, supplant the original herd. Before the new herd of young cattle is placed in premises occupied by the old herd, these premises must be disinfected with the greatest thoroughness and painstaking care.

If the herd owner practices this method he should accompany it by the removal from the old herd of all cows that have nodulated or indurated udders a chronic cough or diarrhoea, those that discharge from the vagina and those that become thin while feeding well. The other cows will probably give birth to healthy calves and if the calves are removed without delay and fed on milk that has been heated to 185° F. for ten minutes they will remain sound.

Of course, the public health side of this question must not be lost sight of. If the milk from the old herd is used, it should be heated or the cows subjected to frequent careful veterinary examinations (special attention being devoted to the udders), and their milk to frequent bacteriological tests.

In the second chapter of this report, attention is called to the general conditions that facilitate the spread of tuberculosis in herds

and in individuals. The avoidance of the conditions that are favorable to the dissemination and progress of tuberculosis must depend largely upon the voluntary acts of the owners of cattle. As Prof. Bang has said, *owners of cattle ought to prevent the contamination of calves and other animals still healthy.*

PUBLIC MEASURES TO SUPPRESS TUBERCULOSIS OF CATTLE.

It appears desirable to preface the discussion of public measures to suppress tuberculosis of cattle by a very brief history of veterinary sanitation. This subject is of such recent development in this country that an introduction may not be out of place.

"In the eighteenth century contagious diseases of animals prevailed extensively throughout Europe, causing famine and ruin. Veterinary sanitary science was called into being to check the distress resulting from this condition.

The first step was to organize, formulate and distribute the knowledge applicable to the suppression of animal diseases that was already available; the next step was to gain more knowledge by experience and research. This work was assigned to the institutions founded chiefly for this purpose and known as veterinary schools. The first of these schools was established in France in 1762 and this example was quickly followed by every civilized country in Europe. Effective systems for the control of the diseases of animals have been developed only since these schools have been in operation.

During the present century, rinderpest has been crowded out of Europe by the well planned veterinary operations directed against it. The distress caused by this single disease can scarcely be appreciated in the present day, although we may gather an idea from its recent ravages in South Africa. In that country it brought large agricultural sections to a condition of unproductivity; it cut off their means of communicating with the outer world and these and other hardships from the same cause led some of the native tribes to rebellion. From 1740 to 1750, England lost 3,000,000 cattle from this disease. From 1745 to 1753 Denmark lost 2,000,000 cattle. During the several outbreaks that occurred during the eighteenth century, Germany lost 30,000,000 cattle, and Europe lost more than 100,000.00.

Anthrax was at one time distributed over a large proportion of the cultivated area of the earth and frequently extended from animals to man. By investigations of bacteriologists, the cause of anthrax was discovered, veterinary measures were adopted to restrict its spread, and it has thus been checked and deprived of many of its terrors.

But a few years ago, contagious pleuro-pneumonia of cattle imminently threatened the live stock industry of this country. The disease had been imported from Europe and was carried to a number of States along the Atlantic seaboard and then inland as far as Missouri. Several thousand herds were involved in different parts of the country and at different times, and losses amounting to several millions of dollars occurred. But notwithstanding the immense headway that the disease was permitted to acquire, it was completely stamped out by appropriate public measures, and not a case of contagious pleuro-pneumonia has occurred in the United States for seven years.

Glanders was formerly an exceedingly prevalent disease among horses and mules. Every horse breeder and horse owner was obliged to exercise the greatest care in order to protect his animals from contamination and even with this care, it invaded many of the best farms and stables in the country and numerous cases are recorded in which men contracted this deadly disease from horses in their charge. Active veterinary measures have been directed against glanders for a number of years, and now the disease is almost exterminated in many states.

Every stockman will remember the frequent and destructive outbreaks of Texas fever that occurred among the cattle of all the northern states every summer up to a few years ago. Researches conducted by the Bureau of Animal Industry in Washington revealed the cause of this disease and its method of transmission. Measures to check the spread of Texas fever based upon these discoveries were formulated and are now enforced with such success that Texas fever is practically an unknown disease among the cattle in northern states—the very districts where it formerly caused enormous losses.

These successes could not have been obtained without strenuous and continuous effort on the part of veterinary sanitarians. This work has been checked from time to time until unbearable conditions developed, when it was again resumed. The history of the operations directed against contagious pleuro-pneumonia in this country, are replete with illustrations of this statement. When Congress was asked to provide an appropriation for the suppression of this disease it was stated by many and this opinion was voiced by a prominent member from a New England state, that pleuro-pneumonia of cattle was not contagious and, therefore, the appropriation asked for was not necessary. The Bureau of Animal Industry was then required to conduct experiments to show conclusively that the disease was contagious as claimed and as has been well known to veterinarians for hundreds of years. Before these experiments were completed, while so many were declaring through the public prints that the disease was not dangerous or contagious and that our immense cattle industry was

not imperiled, a distinguished member of the veterinary profession offered a large reward for evidence that would show that the claims made by veterinarians in regard to the communicability of pleuro-pneumonia, were wrong. It is only necessary to add that the reward was never claimed and that the experiments made by the Bureau of Animal Industry proved the intense virulence of this disease. But objections did not stop at this point. In suppressing pleuro-pneumonia, it was found necessary to restrict the movements of cattle in infected districts, thus interfering temporarily with a small part of the cattle trade, whereupon the inspectors were assailed most viciously, as "cattle thieves," "pleuro-pneumonia boodlers" and so on. But, in spite of opposition, the work continued and the disease was eradicated in a shorter time and more economically than similar work has been accomplished in any other part of the world."

Since so much has been accomplished in the repression or eradication of other widely distributed disastrous diseases of animals, we should be encouraged to expect favorable results in the combat with tuberculosis.

The struggle against tuberculosis cannot be said to have commenced systematically and actively until after the epoch-making discovery of the tubercle bacillus by Koch in 1882 and the subsequent acceptance of his proof that the tuberculosis of animals and of man are identical. Since that time, more attention has been devoted each year to this subject and numerous operations against this disease have been planned and some of them have been enforced, with more or less satisfactory results.

The public operations directed against tuberculosis may be divided into three general classes: (1) compulsory, (2) voluntary and (3) a combination of these two.

(*1*) *The compulsory method* reached its greatest development *in Massachusetts.* It was proposed there to test all the cattle in the state with tuberculin. This examination was to commence at the eastern extremity of the state and progress westward. The inspected area was always to be divided from the uninspected area by a quarantine line extending from north to south. Cattle were not to be permitted to cross this line into the inspected area until it was shown by the use of tuberculin that they were free from contagion. Furthermore, all cattle coming into the state were to be tested with tuberculin and were obliged to pass through certain specified quarantine stations for this examination. The tubercular cattle found in the progress of the work, if they had been in the state for a certain length of time, were appraised at full value, up to the maximum of $60.00, and killed. Their flesh was destroyed.

It was soon found that this plan would involve the expenditure of enormous sums and it was so obnoxious to the owners of cattle that it was abolished by the Legislature after it had been in operation one year. The method that was afterwards followed, consisted in the inspection of all the herds in the state by local inspectors appointed by the different towns. These inspectors reviewed all of the cattle in their district at least twice a year. Animals that were suspected of tuberculosis were placed in quarantine, subjected if necessary to

the tuberculin test by agents of the State Cattle Commission and if condemned, they were appraised and destroyed. Whole herds were tested only upon the application of the owner and upon agreement with him that was planned to insure the permanency of the work. It was not possible, however, to accede to more than a small percentage of the applications for voluntary inspection, because the major portion of the energy and resources of the Cattle Commission were devoted to the examination of and, compensation for, cattle isolated by the local inspectors. In 1897, it was reported that the prevalence of generalized tuberculosis had been reduced from 32.6 to 3.6 per cent. of all cattle condemned. By this method, only the advanced cases in the herds were detected and removed. The earlier (younger) cases were not detected by the physical examination made by the local inspectors and they were therefore permitted to remain in the herd.

This system was of benefit in two ways: It was the means of furnishing to consumers of milk and dairy products very valuable protection by removing from dairies many cattle that were dangerous to public health; it was also of advantage to herd owners in that it relieved them of the losses that they would sustain from tuberculosis, if their badly diseased animals were not appraised and taken in charge by the Commonwealth. For the owners, it was, in effect, a free insurance system whereby they were protected from loss from tuberculosis. But this system was of less value in respect to eradicating the disease in herds. It is true that it was the means of removing the advanced and most dangerous cases, but the cases of less development were allowed to continue, and experience teaches that these furnish a potent means of spreading contagion, and are sufficient to propagate the disease indefinitely. At the 1897-1898 session of the Massachusetts Legislature, no appropriation was made to the Cattle Commission for payment for cattle condemned by local inspectors, so that for a time local inspections served to protect public health at local expense and the expense of the dairymen. This plan did not prove satisfactory, so the next Legislature (1899) appropriated $75,000.00 for the purpose of the Cattle Commission, to be used principally in paying for cattle condemned by local inspectors.

The radical system originally proposed in Massachusetts for the examination of all of the cattle in the state and the stamping out of tuberculosis has not been attempted in any other part of the world. The method that resembles it most closely is the one adopted experimentally by Belgium in 1895 and continued for nearly two years, when it was found necessary to use a less expensive plan.

In Belgium, it was provided that all herds in which tubercular cattle were found by clinical examination or by meat inspectors, should be tested with tuberculin. The reacting animals showing

clinical signs of tuberculosis, were obliged to be killed. The reacting cattle not showing clinical signs of tuberculosis, could be retained, although it was necessary to keep them entirely apart from the non-reacting portion of the herd. Up to the close of 1896, 19,000 cattle had been tested with tuberculin; of these 9,289 presented characteristic reactions, 48.88 per cent., or nearly one-half of the whole. 3,494 of these reacting animals were killed at once and the owners were permitted to keep the others alive under the requirements prescribed. The animals that were killed were taken to slaughter houses and killed under inspection. When the meat was seized as unfit for food, seven-tenths of the value of the meat was allowed the owner by the State. One-fourth of the value of the animal was allowed in all cases where slaughter was required. The indemnities allowed under this law amounted in one year to 721,584 francs.

The present arrangement is based upon a regulation bearing date of August 10, 1897. This provides for the immediate killing of all animals that are clinically tubercular. From 0.25 to 0.70 of the value is allowed in such cases, dependent upon whether the cattle are for the dairy or for breeding.

(*2 and 3*) *Voluntary measures* directed against tuberculosis are followed in most of the countries of Europe and appear to give the greatest satisfaction to the owners of cattle, and under them substantial progress is being made in the direction of eradicating tuberculosis. In many instances *compulsory features are coupled with* systems that are in the main voluntary.

In Switzerland, the method of control is unique. Herds are tested there upon the owner's request at the expense of the government and the animals that show clinical signs of tuberculosis are destroyed. The other tubercular animals (those that react but do not show clinical signs of tuberculosis), are marked by cutting a triangular piece out of one ear and the owner is permitted to dispose of them gradually and in a way that will cause him the least loss. As this method of marking is generally known, all buyers are warned and practically all of these cattle are killed in slaughter houses subject to veterinary control.

In France, the law provides for the immediate slaughter of cattle that are recognized as tubercular by clinical examination and, further, for the slaughter within one year of cattle condemned by the tuberculin test. The owner receives a partial indemnity in cases in which the flesh is deemed unfit or unsafe for human food. The amount of indemnity is equal to one-half of the value of the meat seized in generalized tuberculosis and to three-fourths of the value of the meat in cases of local tuberculosis.

The use of tuberculin is growing in Switzerland and France in all of the cantons and departments, and the statistics show a regular

increase in the number of animals tested. All cattle coming into these countries, unless for immediate slaughter, are tested with tuberculin.

In some parts of *Germany*, the prevalence of tuberculosis is very great and the government is making extensive experiments for the purpose of ascertaining the best and the most economical method of procedure. There is so much tuberculosis among German cattle that the magnitude of the problem is staggering. Methods that are being tried in Germany are based upon the recommendations of Bang, Ostertag and Siedamgrotzky. The larger German states are doing a great deal to encourage the voluntary use of tuberculin and voluntary prophylactic measures. The Prussian Minister of Agriculture has published a pamphlet in which instruction is given as to the nature and the importance of tuberculosis in cattle and a description is furnished as to the method that may be employed to suppress it. The method advised is similar to that of Bang. In all these German states there are official veterinarians who are prepared to advise and assist in this subject; tuberculin is furnished by the government free of charge and monetary assistance is afforded stock owners who will engage to adopt certain approved plans for eradicating disease in their herds. In most of the German states there are regulations requiring the heating of skim and butter milk returned from creameries and the destruction of the separator sediment. All cattle coming into the country are tested with tuberculin. All animals killed for food are inspected at the time of slaughter. If the flesh is condemned on account of tuberculosis, no indemnity is allowed.

In Denmark, more work has been done in the direction of suppressing tuberculosis of cattle and the results achieved are of greater value than in any other part of the world. The importance of this subject is very great in that country since dairying constitutes its leading industry. Under the Danish (the Bang) method, an appropriation of $27,000 per year is available for the inspection and for partial remuneration for some of the cattle that are condemned. It should be stated that most of this money is for the payment of inspectors since, under the Danish system, as will be shown later, comparatively few tubercular cattle are destroyed at public expense. The work in Denmark has been going on on a large scale since 1893. The law has been changed and the work is now conducted under the act approved 26th of March, 1898. This law provides for the inspection of herds where owners will agree to observe the conditions that are imposed by the authorities having the work in charge.

The system, in short, is as follows: Tuberculous herds are tested with tuberculin upon application of the owner of the cattle. After the test, the herd is divided into two parts, the healthy section and

the reacting or tuberculous section. These herds are, if possible, kept in separate buildings. If this cannot be done, they are kept in separate parts of the same building, a tight partition separating them. The milk from both sections is used by the creameries, but it is the almost universal practice in Denmark to pasteurize the cream preparatory to ripening it for churning, and the law requires that skim milk shall be heated to a point that will kill the tubercle bacilli, before it is returned to the farmers to be used for feeding purposes. The law further provides that the sediment that remains in the separator shall be burned.

The calves from the cows in the reacting sections, are removed from their dams immediately after birth and are reared on the milk of healthy cows or on milk that has been heated. These calves are tested when they are three or four months old and if they do not react, they are permitted to enter the sound section of the herd. As a matter of fact, reactions are very rare among these calves. Most of them are born healthy, and, when cared for as directed, they remain free from tuberculosis. All cows with tuberculosis of the udder, are required to be reported and are killed. Some compensation is allowed for them. The appraisement is equivalent to one-fourth of the meat value of the animal. The other tubercular cattle in the reacting section are killed from time to time in public abattoirs under veterinary control, as the owner wishes to dispose of them. Their flesh is then disposed of in accordance with the recommendation of the inspector. Some of it is seized and destroyed, some of it is sold for food. The law further provides that cattle brought into Denmark from other countries, shall be kept in quarantine until they are tested with tuberculin and found to be free from tuberculosis. Up to May, 1898, 224,969 cattle had been tested in 7,898 herds. Of these, 64,707 or 28.8 per cent., reacted to tuberculin.

The use of tuberculin is constantly growing and the percentage of tuberculosis in the reacting herds is steadily diminishing, as is shown by the following table giving the percentage of reacting animals among the cattle tested during the years mentioned:

	Per cent.
Until June 1894,	40
June, 1894, to February, 1895,	36.5
February, 1895, to October, 1895,	39.2
October, 1895, to May, 1896,	31.8
May, 1896, to June, 1897,	25.5
June, 1897, to June, 1898,	23.9

It will be observed that the prevalence of tuberculosis in 1894 was 40 per cent. and has been reduced in four years to 23.9 per cent. This speaks in the highest terms for the value of the system employed. The following table gives the number of reacting animals at different ages and at different periods of the work.

	Calves Under 6 Months.		Cattle from 6 to 18 Months.		Cattle from 1½ to 2½ Years.		Cattle Above 2½ Years.	
	Number tested.	Per cent. reacting.	Number tested.	Per cent. reacting.	Number tested.	Per cent. reacting.	Number tested.	Per cent. reacting.
Tests made before October, 1895, ...	7,630	15.5	11,313	29.4	8,921	40.5	25,439	49.3
Tests made from May, 1896, to May, 1898, ...	24,267	10.6	36,920	19.0	22,425	25.6	67,263	32.8

It will be seen that there has been a marked diminution in prevalence at all ages.

A great many herds (20 per cent.) have been tested in Denmark in which it was found that there was absolutely no tuberculosis. This proves conclusively that tuberculosis is not a necessary disease among highly developed dairy cattle, as has been claimed by so many writers, and that the tubercle bacillus is not omnipresent.

It will be observed that the tubercular cattle are not removed at once from the farms in Denmark but are kept apart from the healthy and permitted to remain for some time, in some cases for three years. The thoroughness of separation has differed greatly on different farms and was previously much less complete than it is now. The herds have all been retested a number of times and the percentage of cattle that have reacted upon retest has been 12.7 per cent., depending, in individual cases, upon the thoroughness of separation.

It is now proposed by Professor Bang to encourage the killing of animals discharging many tubercle bacilli, by giving owners indemnity for such animals. This is to be allowed only in cases where owners voluntarily agree to rid their herds from tuberculosis by the aid of tuberculin and separation. Bang does not merely recommend an indemnity for all animals clinically affected with tuberculosis, because he has found that tuberculosis cannot be eradicated by such means, and it is necessary to supplement this procedure by separating the reacting animals from those that are healthy.

The Danish work has shown that tuberculosis in herds can be greatly checked by the measures applied in that country. The

method has been considerably improved by the law of 1898 and still further progress is to be expected in the future. It is admitted there that more rapid progress could be made if more money were available for use in indemnifying owners of tubercular animals, so that more of the dangerous cases could be slaughtered at once. It is very difficult to isolate these cases thoroughly, and when not thoroughly isolated, they are the source of much danger to other cattle.

In Norway, the government tests herds upon request of herd owners and upon their agreement to observe and perform the following: A, to kill all cattle with advanced or general tuberculosis, and all that are emaciated; B, to isolate from the healthy cattle all that react to tuberculin; C, to disinfect the stable; D, to brand the infected cattle and to sell them only for immediate slaughter (all slaughter houses are under inspection in Norway), and (e) to test all additions to the herd.

For cattle that are killed on account of tuberculosis, either under section A of the above agreement or because the owner does not wish to be annoyed with reacting cattle on his place, the government allows one-half value.

This system is similar to the one followed in Pennsylvania, and on this account, it is interesting to note the results that have followed its application. It has been in operation since 1895. From that time to the end of the year 1899, there had been tested 7,133 herds, comprising 82,201 cattle. Of the herds 24.6 per cent. were infected, and of the cattle 6.53 per cent. were tubercular. These percentages give the averages for the whole period of operation. In 1898, 1,465 herds comprising 14,740 cattle were tested. Of the herds 22.6 per cent. were infected and 4.92 per cent. of the cattle were tubercular. So under this plan tuberculosis is actually declining in Norway.

The method of control that has been recommended *in England* by the Royal Commission appointed to inquire into the administrative procedures necessary to protect the public from the dangers arising from the products of tubercular cattle, are similar to those employed in Denmark. The Commission visited Denmark and was much impressed with the efficiency of the methods employed there.

In the United States, all animals for breeding purposes imported from Europe or Canada must be tested with tuberculin, and the shipment of clinically tubercular cattle from one state to another is prohibited. An inspector has recently been sent to England to test there all cattle that are intended to be shipped to the United States, and similar arrangements are made in regard to cattle shipped from Canada. But most of the practical work of suppression is conducted by the individual states.

In Illinois the method of control of tuberculosis consists in examination of herds upon request of the owner, and the slaughter of

reacting animals. The reacting animals are slaughtered in slaughter houses and their flesh is disposed of in accordance with the decision of the inspector who is on hand to see them killed. The owner of the cattle receives the amount derived from the sale of the flesh and is not granted additional indemnity by the State. The Cattle Commission has applied for an appropriation for use in indemnifying owners of tubercular cattle.

In New Jersey, inspections are made upon application, but, as a rule, whole herds are not tested. The test is usually confined to animals that are suspected from clinical examination, although sometimes the test is applied to all the members of the herd. The reacting cattle are appraised, paid for by the State and killed. Their flesh is not used for food in any case. By this method, all of the diseased animals, are not removed from the herds, and the effect is to insure the owner against loss rather than to completely eradicate disease.

In Maryland, a physical examination has been made of all herds producing milk for shipment, and tuberculin tests have been applied, where needed, as far as the appropriation would permit.

In Delaware, herds have been tested under the supervision of the Director of the Agricultural Experiment Station and information in regard to tuberculosis is distributed by the same official.

In Massachussetts, the method is that described on page 158.

In Vermont, herds are tested upon the owner's request, and suspected herds are examined. Reacting cattle are appraised and destroyed.

One-half value is paid, the limit being forty dollars. The prevalence of tuberculosis has been reduced in Vermont to a point where there is little danger or loss. The Cattle Commission of that State has cause to believe and has stated that it may be possible to eventually exterminate it.

In New Hampshire, entire herds are tested upon the owner's request, and one-half value is allowed for tubercular cattle. Diseased cattle are reported to the Cattle Commission through the selectman.

In New York, the State Board of Health has made inspections of herds supplying certain cities with milk, of some herds thought to be infected and other herds on the owner's request. Reacting cattle are appraised and destroyed.

In Michigan, suspected herds are tested by the Live Stock Sanitary Commission and reacting cattle are isolated. The reacting cows may be kept in isolation indefinitely or may be killed by the owner. No compensation is at present allowed for such animals, but the Commission favors a grant for this purpose. Most of the inspections are voluntary on the part of the owner.

In Minnesota, cattle that show symptoms of tuberculosis are quarantined and the whole herd is tested.

Other States have adopted methods that correspond in general features with some of those described; the benefits of the work being controlled by the appropriations available, the thoroughness of the system of inspection and isolation, and the readiness with which cattle owners co-operate with the authorities. In nearly all of the states, some progress is being made.

Seventeen states, Canada and New York city now require dairy cows and cattle for breeding purpose from without their borders, to be tested when imported.

CHAPTER X.

THE PENNSYLVANIA PLAN FOR CONTROLLING TUBERCULOSIS OF CATTLE.

SUMMARY.

THE PENNSYLVANIA PLAN FOR SUPPRESSING TUBERCULOSIS OF CATTLE CONSISTS IN CO-OPERATION BETWEEN THE OWNERS OF TUBERCULOUS HERDS AND THE STATE, IN ACCORDANCE WITH AN AGREEMENT THAT IS DESIGNED TO MAKE PERMANENT THE RESULTS OBTAINED.

UNDER THIS AGREEMENT, HERDS ARE INSPECTED AT THE EXPENSE OF THE STATE AND THE TUBERCULAR CATTLE ARE DESIGNATED. THESE ARE REMOVED FROM CONTACT WITH HEALTHY CATTLE AND, AT THE OPTION OF THE OWNER, THEY ARE KEPT AND USED, UNDER CONDITIONS PRESCRIBED BY THE STATE LIVE STOCK SANITARY BOARD, OR THEY ARE APPRAISED AND DESTROYED.

THE APPRAISEMENT MUST BE FIXED IN ACCORDANCE WITH THE ACTUAL VALUE AND CONDITION OF THE ANIMAL AT THE TIME OF APPRAISEMENT, BUT CANNOT EXCEED $25.00 FOR COMMON OR GRADE CATTLE, NOR $50.00 FOR REGISTERED CATTLE. IF THE ANIMALS ARE KILLED, THE AMOUNT OF THE APPRAISEMENT IS PAID BY THE STATE.

FOLLOWING THE INSPECTION, THE OWNER IS REQUIRED, AT HIS OWN EXPENSE, TO DISINFECT THE PREMISES OCCUPIED BY TUBERCULAR CATTLE, TO CORRECT FAULTY SANITARY CONDITIONS AND, SUBSEQUENTLY, TO USE DUE CARE IN SELECTING ADDITIONS TO HIS HERD. A RETEST IS MADE OF BADLY INFECTED HERDS AND THIS IS REPEATED AS OFTEN AS MAY BE NECESSARY TO ENTIRELY ERADICATE DISEASE.

CATTLE DEALERS ARE ENCOURAGED TO TEST CATTLE THAT ARE TO BE SOLD.

ANIMALS WITH ADVANCED TUBERCULOSIS AND COWS WITH TUBERCULOSIS OF THE UDDER ARE ISOLATED AND HELD IN STRICT QUARANTINE UNTIL THEY ARE KILLED.

DAIRY COWS AND CATTLE FOR BREEDING PURPOSES COMING INTO PENNSYLVANIA ARE KEPT APART FROM OTHER CATTLE UNTIL THEY ARE SHOWN BY INSPECTION AND TUBERCULIN TEST TO BE FREE FROM TUBERCULOSIS.

UNDER THIS SYSTEM, THE FREQUENCY OF TUBERCULOSIS IN THE INFECTED HERDS OF THE STATE HAS BEEN REDUCED MORE THAN ONE-HALF AND THE NUMBER OF INFECTED HERDS HAS BEEN VERY GREATLY DIMINISHED.

THE TERMS OF CO-OPERATION THAT HAVE BEEN ESTABLISHED UNDER THE PENNSYLVANIA PLAN HAVE BEEN SO SATISFACTORY TO HERD OWNERS THAT ABOUT FOUR TIMES AS MANY INSPECTIONS ARE ASKED FOR AS CAN BE MADE WITH THE FUNDS AVAILABLE FOR THIS PURPOSE.

IT IS CLEAR THAT THE FARMERS OF PENNSYLVANIA WANT THEIR HERDS FREED FROM TUBERCULOSIS AND THEY ARE CO-OPERATING, VOLUNTARILY AND ACTIVELY WITH THE STATE LIVE STOCK SANITARY BOARD TO ACCOMPLISH THIS RESULT.

THE ANIMAL HUSBANDRY OF PENNSYLVANIA.

In order that the conditions under which the work that is directed against tuberculosis of cattle in Pennsylvania is conducted may be made clear to those who are not acquainted with all parts of the field, a brief review of the character of the agriculture of the State is here given. Pennsylvania is a large State of wonderful diversity of topography, soil, population and industry. It has a mean length of about 300 miles, is 158 miles wide, and covers 45,086 square miles, or 28,808,443 acres. This area is nearly as large as England and about one-fourth as large as France.

The surface of the State comprises hills, mountains, valleys and plains and, in general, is very well watered by springs and streams. Such noble rivers as the Delaware, Schuylkill, Susquehanna, Juniata, Allegheny, Monongahela and the Ohio traverse this territory.

There is as much diversity of soil as of configuration. The river valleys and the high mountain valleys have soil that, in general, is very rich and productive. Some of the most fertile farms in the United States may be found in the southeastern counties of Pennsylvania and in the northwestern corner of the State. And many of the high interior valleys have soil that is of the strongest and most productive character. Large sections of the State are high and rolling, as the counties of Bradford, Susquehanna, Crawford, Somerset, Fayette, Washington and Greene. These districts are splendidly adapted to the rearing of stock and each of the counties named is famous for some product dependent upon animal husbandry.

Throughout the middle of the State, with a general trend from the northeast toward the southwest, are the ridges of the Allegheny and the Blue mountains. The higher mountains and some of the highest table lands are made up largely of bare, outcropping rock. The lower valleys, however, and the valleys through which streams run, usually contain arable soil that is always of good quality and in some places of considerable extent.

Almost the entire State was once covered with timber. The western and northern part of Pennsylvania and restricted portions of the southern and eastern parts of the State are well adapted to the growth of grasses and, especially, the natural grasses that make permanent pasture. In these sections, cattle are pastured from early spring until late fall. In some mountainous parts of the State, the wild land is utilized for pasturing young cattle. In these sections, growing animals are turned out in the large, unfenced mountain ranges for the entire season. These cattle roam in herds of from twenty-five to one hundred. They are seen and salted occasionally

during the summer, but are not cared for beyond this until they are brought down to the farms in the fall. During the summer they find grass in the little valleys and along the streams and they also subsist in large part on the foliage of the trees and underbrush. Usually this food is sufficient to keep them in good growing condition and sometimes it is so plentiful and nutritious that, when the cattle are brought home in the fall, they are round and fat.

The industries of Pennsylvania are so numerous and many of them are so important, that the agriculture of the state is somewhat overshadowed. It is not generally known that Pennsylvania is one of the most important agricultural states in the Union. If Pennsylvania did not have the important mining, manufacturing and lumber interests that she has, the agricultural industry would still suffice to give her an important and dignified position among her sister states.

The cattle industry is the most important of the numerous divisions of the agriculture of the state and this industry differs greatly in different sections. The farms in the southeastern corner of the State are the oldest and this region is well known as one particularly fitted for dairying. Southeastern Pennsylvania has always led other parts of the country in all branches of dairy husbandry. The country is rolling, fertile and well watered. Springs of cool, clear water are abundant. For many years a large proportion of the finest butter made in the United States was produced in this district and although butter making is now being gradually crowded out by milk shipping, no butter has a better reputation or commands a higher price than that made in this very section.

On the small high priced farms near Philadelphia, and especially in the counties of Montgomery, Bucks, Lehigh, Berks, Chester and Delaware, it is now the practice of a great many dairy men to buy their cows. These cows are brought in by dealers from central and western Pennsylvania, Ohio, Indiana, Illinois, Maryland, Virginia and from western New York. The so-called mountain cows of Pennsylvania are highly esteemed by many dairymen; others prefer large cows containing a considerable admixture of short-horn blood. The dairymen who milk their cows but one season and then fatten for the butcher, prefer large animals; those who intend to keep their cows as long as they are profitable in the dairy, are more inclined to purchase smaller animals of special dairy type which show evidence of Jersey or Guernsey blood. Milch cows are usually brought in by the carload and sold at auction. At this time, the prices range from $40 to $55 or even $60 a head. If the dairyman purchases when milk is low in the summer or fall and has plenty of pasturage or rough feed, he often selects cows that will not calve for several weeks. When cows are purchased in the winter, they are wanted for

immediate use and are usually fresh and, as a rule, the calves are sold with the cows and are subsequently resold to the butcher. The cows that prove to be profitable milkers are kept and bred, the others are fattened and sold. Where this method of recruiting herds is practiced, but little attention is given to the character of the bull. Young scrub or grade bulls are brought into this district by the carload and disposed of to dairymen who do not intend to raise their calves.

At somewhat greater distances from the city, where land is not quite so valuable and farms are larger, many dairymen raise their own cows. Some of the herds on these farms are devoted to both dairying and breeding and are of the highest quality. Many herds of registered Jersey, Guernsey, Holstein and Ayrshire cattle are used in this way. Some of the males are sold to other dairymen who use them for the purpose of improving their cattle. Unfortunately, however, a great many farmers who raise their cows, do not appreciate the value of well bred sires and of breeding in the same line long enough to derive permanent benefit. Such men use cheap grade bulls that are shipped in, the character of whose progeny cannot be foretold and is usually disappointing. There is no particular reason, other than failure to appreciate the advantages of well bred animals, by which this practice may be accounted for. The well bred bulls need not be expensive and, if purchased young, can frequently he had for a very slight advance on the cost of nondescript males.

Many of the present barns in the southeastern or oldest part of Pennsylvania, were built forty or fifty years ago, before much milk was produced for city consumption and before winter dairying was practiced extensively. It follows, therefore, that the barns were constructed for a purpose entirely different from the one for which they are now used. Moreover, when they were built it was the practice of the farmers through nearly all of this section to feed steers, so during the winter the barns now occupied by milch cows were occupied by dry cows, young cattle and steers. The barns were constructed with special reference to convenience of feeding and to keeping the animals warm. The hay mows are directly above the stables and are connected therewith by chutes. The ceiling of the stable is at the same time the floor of the hay mow. This is sometimes loosely constructed, so that the seeds and dust from above, can sift down through the cracks. The walls are constructed of rough masonry or boards containing many projections and crevices. As originally constructed, these stables were badly lighted because the importance of light was not then appreciated and it was considered that the stable would be too cold if it had large windows.

Moreover, glass was expensive and fragile. The typical Pennsylvania barn has an overhang formed by projecting the upper part of the building on one side from four to ten feet beyond the stable wall. This enlarges the mow space, protects the entrance to the stable from the weather, keeping the ground dry about the stable doors and at the same time has the effect of reducing the light in the part of the building that is occupied by animals. Many of the newer barns do not have the overhang because there is not so much need now for great storage capacity, since less grain is raised and the silo has come into such general use.

On some farms, these old barns have been greatly improved by putting in cement floors, by ceiling them tightly, by cutting windows and by adding the area protected by the overhang to the stable. This last improvement is made by building a wall containing many windows parallel to the stable wall that is protected by the overhang, and at a distance from it equal to the distance that the second story projects beyond the first story. Then the stone wall thus enclosed can be removed, leaving only so much of it as is needed to support the super-structure; or all of it can be taken away and the superstructure supported by posts. The stable is in this way increased in size and is lighted.

A number of farms are equipped with stables built for the special purpose of housing dairy cows. These stables are sometimes independent buildings, in other cases they are additions to the old structure. The best of them are but one story high, and are devoted exclusively to the housing of cattle, feed being stored in one end of the structure or in a detached building. The newer stables have impervious floors, smooth walls and ceilings that will not collect dirt and are flooded with light. The stalls of some of the cow stables are equipped with automatic watering devices but usually the cows are watered in the stable yard from a common trough. When the watering device is used, the cows are sometimes deprived of exercise during the winter except for brief periods on days when the sun is shining brightly.

Milk produced in this region is shipped to the city, is made into butter on the farm or sent to the creamery or condensary. When it is used for butter making, the skim milk is made into cottage cheese or died curd or it is fed to calves or pigs. The skim or butter milk that is returned by the creameries to farmers for feeding to animals, is taken from a mixture of the product of all the patrons of the creamery; it is not heated and no precaution is taken to prevent the dissemination of tuberculosis even though one or more of the patron's herds be infected to such an extent as to cause the production of tuberculous milk. This is the general rule to which there are very few exceptions.

In other parts of Pennsylvania, fewer cows are purchased. Indeed, excepting the southeastern part of the State, cows are produced for sale and many Pennsylvania cows are bought by dealers and used to replenish the dairies of eastern New York, New Jersey and the New England States. The northeastern part of Pennsylvania is especially well adapted for dairying. The climate is favorable, the soil fertile and the locality is healthful. A great deal of milk is produced for New York city and Philadelphia whither it is carried by daily milk trains run over the Delaware, Lackawanna and Western and the Lehigh Valley Railroads. These trains start in New York State, but receive a large proportion of their loads in northeastern Pennsylvania. In addition to producing milk for shipment, much butter is made.

The cattle of this section have been influenced very much by the use of Jersey bulls. Many farms are stocked with full bred or high grade Jerseys. Guernseys are also coming into use considerably and there are a few Ayrshire, Devon and Holstein herds. The dairy short horns are also represented. Generally, the cattle of these regions are well selected for the purpose for which they are used. The feeding of steers was once practiced extensively in this section but has now, in almost all localities, given way to dairying.

In the northern, central and western parts of the State there is, comparatively speaking, not much exchange of cattle among farmers. The cows are in most cases reared on the farms on which they are in use and not many are moved until they are sold for shipment to distant places. Most of the milk produced in the vicinity of Scranton is sent to that city or to the condenseries or the creameries in the neighborhood.

In the northern tier of counties and in the northwestern part of the State, some cheese is made.

In the western end of Pennsylvania the farms are larger than in the eastern section and the cattle industry is very different from that in the eastern districts. While dairying is practiced extensively and much milk is produced for shipment to Pittsburgh, Allegheny and Erie and the numerous thriving, manufacturing cities and towns, and a good deal of it is made into butter and some into cheese, the cattle industry is by no means confined to dairying. Many cattle are raised for beef and there are some herds of Short-horn, Hereford and Angus stock. The beef cattle fed in this district are, in part, reared in the localities in which they are fed, but many of them are western bred and purchased in the stockyards at Pittsburg or Buffalo. Jersey cattle are also bred extensively in western Pennsylvania, and some of the finest Jersey herds in the United States are to be found here.

The southern part of the State and especially the Cumberland

Valley and Lancaster, York and Lebanon counties feed a great many steers. From 25,000 to 30,000 steers are sold as feeders every year at Lancaster to the farmers of the neighboring counties. These steers are principally grades of the beef breeds, and are shipped in from the west and south.

Very little milk is shipped from the central part of the State excepting to nearby towns, and cattle are kept for the production of milk that is manufactured into butter on the farms or in the creameries. Some beef is produced and cows are raised for sale to eastern buyers.

From 4,000 to 5,000 cows are sold at the Pittsburg stockyards each year to nearby dairymen.

Origin of bovine Tuberculosis in Pennsylvania.—Just when tuberculosis first appeared among the cattle of Pennsylvania cannot be determined. There can be no doubt that it was brought in from without with some of the animals imported from Europe by Pennsylvania or some other of the early colonies.

That it was not prevalent in the older days is indicated by the fact that the old works and periodicals devoted to agriculture did not mention it. In fact, little thought was given to this disease until about twenty-five years ago. And it is certain that it could not have been common or it would have caused more comment. Professor Bang has observed that the onset of tuberculosis in a locality or in a herd is insidious and gradual. It requires years to become established. When our original importations of cattle were made, there was much less tuberculosis among the cattle of Europe than now. As the disease progressed among the cattle of England and other lands upon which we have drawn for material to improve our herds, the danger of importing tuberculosis has increased. No doubt a great deal of the disease has been imported during recent years.

On account of the methods of using and caring for cattle and on account of the fact that cattle were not moved then to anything like the extent they are now, the disease had comparatively little opportunity to spread. So long as cattle led an outdoor life excepting during severe weather, and so long as winter dairying was not practiced, the opportunities for the distribution of tuberculosis among the members of a herd were not so favorable as they are now. There is, however, some circumstantial evidence of a herd disease that progressed stealthily in certain herds until they were almost or quite destroyed, and the character of the disease, as described, was such that it cannot be identified as anything excepting tuberculosis.

There are still some sections that have adhered rather closely to old methods and are breeding cattle that spring from original stock. In such sections, tuberculosis is a rare disease.

When the great cattle districts of the west were opened and the business of beef production left many sections of the eastern states, dairying took its place. Cows that had formerly produced only a little milk during the pasturing season, were so managed that milk was produced the year around and herds that had averaged about 800 quarts of milk per cow per annum, were changed, bred and fed so that they might produce 2,000 quarts or more per head each year. The farmers that were most successful in dairying gradually increased their herds by buying cows from their neighbors or those from distant places brought in by dealers. With every addition to the herd, there was a chance that tuberculosis might be introduced, and, when many cows were bought, these chances were increased in the same proportion. The herd that became infected, served to distribute disease to other herds replenished from it and thus, in the course of time, tuberculosis became firmly established in many places. Attention has already been called to the fact that tuberculosis once introduced into a country, spreads at a rapidly increasing rate. So long as it is being distributed only from the herd originally infected, the rate of distribution must be slow, but after a number of herds have been infected from this one, the rate is correspondingly more rapid and after a hundred herds are infected and each has become a distributing center of disease, the rate of distribution will be one hundred times as rapid as it originally was. It is on this account that tuberculosis has been spreading with such marvelous activity during the last two decades and, of course, where effective repressive measures are not introduced, the rate of progress will be much faster in the future.

We must also remember that tuberculosis of cattle was not studied seriously until it became extremely prevalent. Consequently, it was not possible to formulate effective repressive measures until a few years ago.

Distribution of Tuberculosis in Pennsylvania.—At this time, tuberculosis has reached all of the more advanced dairy districts of the State, and is most prevalent where cattle are purchased in greatest numbers, and where intensive dairying has been practiced for the longest time. A great many breeding herds (that are not recruited by purchase) even in the worst infected districts, are entirely free from tuberculosis. This shows that the disease does not necessarily accompany intensive dairying. It must first be brought in from without and after such introduction, it will be distributed at a rate that depends upon the character of the conditions to which

the animals are subjected, as has been explained in a previous chapter.* The various ways in which tuberculosis causes loss are mentioned on page 24. The extent of this loss cannot be accurately measured, but almost every one who is interested in cattle and lives in a locality in which tuberculosis exists, is familiar with instances in which herds have been riddled and owners have been ruined by it.

First attempts to check the spread of Tuberculosis.—The need of controlling this disease has been evident for a long time and in view of this need, the law authorizing the Secretary of the State Board of Agriculture to take steps to eradicate contagious pleuro-pneumonia of cattle was so drawn as to confer authority upon the same officer to deal within certain limits with other diseases, including tuberculosis. This law was passed in the year 1889 and was in force until 1895.

The establishment of the State Live Stock Sanitary Board.—The law that follows was enacted by the Legislature of 1895 and approved by the Governor on May 21st of that year.

AN ACT

To establish the State Live Stock Sanitary Board of Pennsylvania, and to provide for the control and suppression of dangerous, contagious or infectious diseases of domestic animals.

Section 1. Be it enacted, etc., That a Board is hereby established to be known as "The State Live Stock Sanitary Board." This Board shall consist of the Governor of the Commonwealth, the Secretary of Agriculture, the State Dairy and Food Commissioner and the State Veterinarian, who shall be a competent and qualified person as provided in the act entitled "An act to create a Department of Agriculture and define its duties."

Section 2. That it shall be the duty of the State Live Stock Sanitary Board to protect the health of the domestic animals of the State, to determine and employ the most efficient and practical means for the prevention, suppression, control or eradication of dangerous, contagious or infectious diseases among the domestic animals, and for these purposes it is hereby authorized and empowered to establish, maintain, enforce and regulate such quarantine and other measures relating to the movements and care of animals and their products, the disinfection of suspected localities and articles and the destruction of animals, as it may deem necessary, and to adopt from time to time all such regulations as may be necessary and proper for carrying out the purposes of this act: Provided, however, in the case of any slowly contagious diseases only suspected or diseased animals shall be quarantined.

* The writer has made this statement at many public meetings and has frequently been asked a question somewhat similar to the following: "If it is true that tuberculosis spreads only from one diseased animal to another and that it is never brought into a herd excepting as the germs are introduced from without, and usually in the body of a diseased animal, where did the first case come from?" It is sufficient to say that the origin of the first case of tuberculosis is unknown, just as the origin of the first grain of wheat or the first acorn, or the first cow is unknown. What we do know, is that wheat never grows unless wheat is planted; that oaks spring only from acorns, and that every cow must have had a father and a mother. We also know that tuberculosis never originates in a herd unless it is introduced from without, just as we know that yellow fever, cholera or small-pox have never occurred in Philadelphia excepting when they were introduced from without. In this it is like all other contagious diseases: measles, mumps, chicken-pox, etc.

Section 3. That when it shall be deemed necessary to condemn and kill any animal or animals to prevent the further spread of disease, and an agreement cannot be made with the owners for the value thereof, three appraisers shall be appointed, one by the owner, one by the commission or its authorized agent, and the third by the two so appointed, who shall, under oath or affirmation, appraise the animal or animals, taking into consideration their actual value and condition at the time of appraisement, and such appraised price shall be paid in the same manner as other expenses under this act are provided for: Provided, That under such appraisement not more than twenty-five dollars shall be paid for any infected animal of grade or common stock, and not more than fifty dollars for any infected animal of registered stock, nor more than forty dollars for any horse or mule of common grade stock and not to exceed fifty per cent. of the appraised value of any standard bred, registered or imported horses.

Section 4. That the Board or any member thereof, or any of their duly authorized agents, shall at all times have the right to enter any premises, farms, fields, pens, abattoirs, slaughter houses, buildings, cars or vessels where any domestic animal is at the time quartered, or wherever the carcass of one may be, for the purpose of examining it in any way that may be deemed necessary to determine whether they are or were the subjects of any contagious or infectious diseases.

Section 5. That any person or persons wilfully violating any of the provisions of this act or any regulation of the State Live Stock Sanitary Board, or wilfully interfering with the officers appointed under this act, shall be deemed guilty of misdemeanor and shall, upon conviction, be punished by a fine not exceeding one hundred dollars or by imprisonment not exceeding one month, or both, at the discretion of the court.

Section 6. That the State Live Stock Sanitary Board is hereby empowered to appoint and employ such assistants and agents and to purchase such supplies and materials as may be necessary in carrying out the provisions of this act, and the Board and the members thereof are hereby empowered to administer oaths or affirmations to the appraisers appointed under this act, that they may order and conduct such examinations into the condition of the live stock of the State in relation to contagious diseases, including the milk supplies of cities, towns, boroughs and villages, as may seem necessary, and to take proper measures to protect such milk supplies from contamination.

Section 7. That all necessary expenses under the provisions of this act, shall, after approval in writing by the Governor and the Secretary of Agriculture, be paid by the State Treasurer upon the warrant of the Auditor General in the manner now provided by law.

Section 8. That this act shall take effect June 1, one thousand eight hundred and ninety-five, and all acts or parts of acts inconsistent herewith are hereby repealed.

Approved—May 21st, 1895.

The authority of the State Live Stock Sanitary Board.—It will be seen that under this law the State Live Stock Sanitary Board is established and is required and authorized to take such measures as may be necessary to suppress or eradicate dangerous, contagious or infectious diseases. It is well that the precise methods to be followed in dealing with such diseases are not inflexibly established by enactment of the Legislature, because as more knowledge of

this subject is acquired and as experience accumulates, methods must change. Hence, if the State is to have the advantage at all times of the best methods, it is necessary that the executive body should be able to change its plans and rules as improved methods are developed.

The membership of the Pennsylvania State Live Stock Sanitary Board was not completed until January, 1896. Hence, its work dates only from that time and not from the time the law was approved by the Governor.

Conditions precedent to the formation of the Pennsylvania Plan. When it became necessary to formulate a plan for dealing with tuberculosis of cattle, considerable difficulty was encountered and many somewhat conflicting conditions and circumstances had to be taken into consideration. While a large number of herd owners had at that time succeeded in eradicating tuberculosis from their herds by the voluntary enforcement of well advised measures, the public work that had been carried out in relation to tuberculosis was by no means promising or satisfactory. In some states the matter had been taken hold of in such an abrupt and radical way that the property rights of herd owners had been unjustifiably interfered with (as in New York) and much opposition had arisen to all measures directed against tuberculosis. The fear that such measures would be repeated, made herd owners timid everywhere. In other states the authorities seemed to be feeling their way; they would isolate or kill a few tubercular cattle here and there apparently without any definite plan or object. Such work was of little general service excepting as it had an educational value; attention having once been drawn to tuberculosis and interest aroused in the subject, it was easier to take more effective measures later on.

It was realized in the beginning by the State Live Stock Sanitary Board that tuberculosis was exceedingly prevalent in some parts of the State; that in some counties in which the dairy industry had reached its highest development, a considerable proportion of the herds were infected. It was realized also, that information in regard to tuberculosis had not been available to herd owners for more than a short time and that many of the statements in regard to the disease that had been made, were from a prejudiced standpoint and were misleading. Moreover, it was believed that there was no justification for the expenditure of State funds in the work of suppressing tuberculosis, excepting under some method that promised to give results that would be reasonably permanent.

An arrangement that was desired by a number of herd owners was that the Live Stock Sanitary Board should authorize payment for cattle in the advanced stages of tuberculosis and pay no attention

to the other members of the herd or the sanitary conditions under which they were kept. A large number of letters were received in which such assistance was asked. If these requests had been acceded to, a number of animals badly afflicted with tuberculosis would have been destroyed and their owners would have received indemnity for their losses. Nothing would have been done, however, in the way of checking the progress of disease in the herd. The other members of the herd that had been exposed to advanced cases of tuberculosis, and some of which were probably infected, and the bad sanitary conditions, would not have received attention. In the course of a few weeks or months another request would have been received from the same herd owner asking that another cow should be taken over by the State and paid for. A little later, another similar request would be received from the same source, and so on indefinitely. To have adopted this plan would have meant the transformation of a work that was intended to have permanent sanitary value into a free live stock insurance operation. The individual herd owners would be helped because the loss occasioned by tuberculosis would have been taken, in part, at least, from their shoulders and placed upon the public treasury. The public, however, would derive little or no benefit from such a plan.

Another plan that suggested itself, was to endeavor to examine all of the cattle in the State in the attempt to discover and remove all tubercular animals. This plan, however, was not considered seriously for several reasons, and particularly on account of the enormous expense that would have been necessary if it had been put into operation. When it is remembered that this method was tried in Massachusetts, a State having but one-fifth the area and one-fifth the number of cattle of Pennsylvania and that expenditures under it amounted to from $200,000 to $250,000 per year, and that even with this enormous expenditure only a small part of that State was covered in this systematic way, the difficulties will at once be apparent.

Since it was not possible (even if desirable, which is not admitted), to systematically examine all of the cattle in the State, why not examine all of the cattle in the districts in which tuberculosis is known to prevail most extensively? It was thought that if this were done, the effect would be to cause dissatisfaction, first, among the owners of healthy herds in such districts who did not need or care to have their cattle examined and, second, among the owners of tubercular herds in other districts who could not have their cattle examined because the resources of the Board were being consumed in the examination of the herds in certain restricted localities.

A number of farmers in different parts of Pennsylvania had taken up the matter of tuberculosis and had themselves done what they

could to eradicate it from their herds, before the State Live Stock Sanitary Board was established and it was apparent that there were many herd owners who desired to place their herds on a healthy basis, if they were given some encouragement or assistance from the State. Experience, everywhere, had shown that it was very difficult for a state to check the progress of this disease and to obtain permanent results without the earnest co-operation of the owners of herds. So many false and misleading statements in regard to tuberculosis had been published that there was in some quarters a widespread misapprehension in regard to the true nature and import of this disease. It seemed evident that with a knowledge of the facts on this question many more farmers would desire to eradicate this scourge from their herds.

The importance of at once disposing of advanced and udder cases was not lost sight of, but it was deemed important that this should be done in some way that should not discourage the complete eradication of tuberculosis in the herds of which such animals were members. In formulating a plan of operation, an attempt was made to develop one with which the cattle owners would be in thorough accord.

THE PENNSYLVANIA PLAN.

With the above facts and the knowledge of the above conditions in mind, the plan of operation that was adopted by the Live Stock Sanitary Board in 1896 and that has since been developed on that foundation, consists in the following:

Circulars are distributed in regard to tuberculosis, the nature, character and importance of the disease; its method of propagation; its results and the methods that may be adopted to combat it. A good deal of the information contained in these circulars has been made use of by various agricultural papers and has thus been given increased publicity. At this time, there is a pretty general realization in all parts of Pennsylvania, of the leading facts in this matter.

Herd owners who have wished to suppress tuberculosis in their herds have been assisted by the State Live Stock Sanitary Board under a definite plan of co-operation. According to this plan the herd owner is required to fill out and sign an application form and agreement as below:

FORM A.

REQUEST FOR INSPECTION AND TUBERCULIN TEST OF HERD, AT THE EXPENSE OF THE STATE LIVE STOCK SANITARY BOARD.

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To the State Live Stock Sanitary Board, Harrisburg, Pennsylvania:

Gentlemen:

I have reason to believe that some of my cattle are afflicted with tuberculosis, and I wish to have my entire herd inspected, and tested with tuberculin, if such test is deemed necessary by your representatives, and the diseased animals disposd of according to the rules and regulations of the State Live Stock Sanitary Board.

I understand that this inspection and test are to be made at the expense of the Commonwealth and, in consideration thereof, I agree to thereafter observe the precautions and measures and to employ the means recommended by your Board to prevent the reintroduction and redevelopment of tuberculosis in my herd.

I certify that to the best of my knowledge and belief, none of the dairy cows or cattle for breeding purposes in my herd have been brought from another state into Pennsylvania since January 1st, 1898, without having been subjected to inspection and tuberculin test, as required by law.

Yours respectfully,

.....

(Address), ...

.....County, Pa.

My herd includes the following animals: Cows, ..., heifers over one year old, ..., bulls over one year old, ..., steers, ..., calves under one year old, ... total ..... The milk from this herd is used by .... for .....

The cattle are .....

(State breed and whether registered)

.....

.....

The following are my reasons for believing that some of my cattle are afflicted with tuberculosis:

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.....

The herd owner is at the same time informed that the inspection will be made only in accordance with the following conditions:

"Upon application from owners of tubercular cattle, the State Live Stock Sanitary Board will furnish tuberculin and inspections free, on condition that the cattle owner will agree to:

"1. Assist in the examination.

"2. Separate the cattle found to be tubercular from those that are healthy, and have them cared for separately until disposed of, as directed by the State Live Stock Sanitary Board.

"3. Disinfect the stables and correct faulty sanitary conditions, as directed by the State Live Stock Sanitary Board.

"4. Discontinue the use of milk and cream from infected cows, except when boiled or heated to 185 degrees F. and kept at this temperature for five minutes.

"Upon application from owners of dairy herds not known to be infected, the State Live Stock Sanitary Board will conduct or direct inspections of cattle and cattle stables and yards, and will furnish certificates showing the health of the animals and the sanitary condition of their surroundings: Provided, That the applicant will agree to bear the necessary expense of such inspection.

After the inspection thus asked for has been made by an inspector selected and paid by the State Live Stock Sanitary Board, the *cattle that show physical evidence of tuberculosis* may be at once appraised and destroyed, the appraisement being made, as required by law, with due regard to the actual value and condition of the animal at the time of appraisement. The limit of appraisement for unregistered cattle is $25 and for registered cattle $50. Anything that may be obtained from the sale of the hide or of the carcass to a fertilizer manufacturer, the owner receives in addition to the appraisement. The members of the herd that do not show physical signs of tuberculosis but react to the tuberculin test may be disposed of in the same way as the animals that show physical evidence of tuberculosis, or if the owner prefers to keep them alive under prescribed conditions, he is permitted to do so.

If the reacting animals are kept, they must be maintained entirely apart from non-reacting cattle. They must be stabled and pastured separately. The owner is not permitted to sell them nor is he permitted to dispose of or use their milk without previous sterilization by boiling or by heating to 185 degrees F. for ten minutes. The progeny of such reacting cows must be removed immediately after birth and reared on the milk of healthy cows or on heated milk from reacting cows. In other words, if the owner prefers to keep his reacting animals alive, he is permitted to do so under regulations similar to those that Bang formulated and that have proven so satisfactory and so safe in Denmark. (See Danish system of controlling tuberculosis on page 247.)

Danish method not generally desired by farmers of Pennsylvania.—It should interest those who have so strongly advocated the adoption in this country of the Danish method for the suppression of tuberculosis to know that this method in its entirety has been offered to the farmers of Pennsylvania for four years and that very few have cared to avail themselves of it. This is not because they do not wish to suppress tuberculosis, because a great many farmers have had

their herds examined and have willingly sacrificed their reacting cows and have accepted the indemnity offered by the State, which is considerably less than the real value of the animals; and this method has been accepted in preference to the Danish method. The reason for this selection is not hard to find. When a Pennsylvania farmer discovers that he has tuberculosis in his herd and resolves to get rid of it, he wishes to have the whole thing accomplished and off of his mind as soon as possible. He does not care to maintain two herds, one healthy and one reacting, and provide separate stable accommodations and separate pastures for them. He does not care to do this because the proper enforcement of this method means a considerable amount of extra work and because there is no market, or a very restricted market, for milk that has to be heated. If butter is made on the farm it is possible to adopt this system with a minimum of trouble and loss; but if the milk is sent to a creamery, the creamery will not care to heat it, as is necessary, and, more than likely, would refuse to take it. Hence, the herd owner almost invariably concludes that it is best to accept the indemnity offered by the State and eradicate the disease at once.

Perhaps, in view of the limited extent to which tuberculosis of cattle in Pennsylvania prevails, the plan that has been chosen by the farmers of this State is, after all, the best and most economical. If, however, tuberculosis were from ten to fifteen times as prevalent as it is; that is to say, if it were as prevalent in Pennsylvania as it is in Denmark and in parts of Germany, the plan that is followed in Pennsylvania would not be feasible because to do the amount of work that is now being done would require from ten to fifteen times as much money or, with the funds now available, the work would have to be restricted to from one-fifteenth to one-tenth of its present proportions, and this would make the repression of tuberculosis too slow.

Applications are numerous.—So many applications for herd tests are made that it is not possible to respond affirmatively to all of them. For this reason each herd owner is required to submit his reasons for believing that his herd is infected with tuberculosis, and an attempt is constantly made to confine the inspections to the herds that are most likely to harbor diseased animals. Where an inspection of a herd is desired merely for the purpose of obtaining information as to its condition and, in the event that it proves to be free from tuberculosis, a certificate of health, the owner is required to pay for the examination. Tuberculin is furnished free of charge by the State Live Stock Sanitary Board for this use. When such a certificate is desired, the following form of application is used:

Form B.

Request for inspection at expense of owner.

..... 190..

To the State Live Stock Sanitary Board, Harrisburg, Pa.:

Gentlemen:

I wish to obtain from you a certificate showing the health of my herd and the sanitary condition of the surroundings, in accordance with your rule providing that such certificate can be granted in cases in which herds are examined under your supervision at the expense of the owners of the cattle. I desire this inspection to include a test with tuberculin.

My herd includes the following animals: Cows, ..., heifers over one year old ....., bulls over one year old ....., steers, ..., calves under one year old, ...; total, ...

It is located on the premises of ..... in ..... Co., Pa.

The milk from this herd is used by ..... for .....

I hereby agree to pay to the representative of the Board who makes this inspection his reasonable and just charge for such service.

Yours respectfully,

.....

(Address), ...

..... Co.

The form of certificate now in use is as follows:

Certificate of Inspection and Tuberculin Test.

This is to certify, That the herd of Mr. ..... of ..... P. O., ... Co., Pa., consisting of the following animals: .... was subjected to a physical examination and to the tuberculin test on the ..... day of ..... 190 by ..... of ..... acting for the State Live Stock Sanitary Board, and the said animals were found to be free from all evidence of tuberculosis or other transmissible disease, with ..... exception : .... and further, that the stables and yards in which these animals are kept were in good sanitary condition.

.....

State Veterinarian.

If it should be found in an inspection at the expense of the owner that the herd contains cattle afflicted with tuberculosis, these may be disposed of just as they are when the inspection is made at the expense of the State, if the owner will sign the form of agreement printed below:

Form C.

REQUEST FOR ASSISTANCE IN DISPOSING OF TUBERCULAR CATTLE.

..... 190..

To the State Live Stock Sanitary Board, Harrisburg, Pennsylvania:

Gentlemen:

I have had my entire herd inspected and tested with tuberculin and have reason to believe that some of my cattle are affected with tuberculosis.

I have had this inspection and test made at my own expense and now wish to dispose of the diseased animals in accordance with the rules and regulations of the State Live Stock Sanitary Board and to avail myself of the assistance afforded by the Commonwealth in such cases. If such assistance is furnished, I agree to thereafter observe the precautions and measures and to employ the means recommended by your Board to prevent the reintroduction and redevelopment of tuberculosis in my herd.

My herd includes the following animals: Cows, ..., heifers over one year old ....., bulls over one year old ....., steers ....., calves under one year old .....; total ..... The milk from this herd is used by ..... for .....

The cattle are .....

(State breed and whether registered.)

The inspection and test were made by ..... of ..... on ..... 190..

I certify that, to the best of my knowledge and belief, none of the dairy cows or cattle for breeding purposes in my herd have been brought from another state into Pennsylvania since January 1st, 1898, without having been subjected to inspection and tuberculin test, as required by law.

Yours respectfully,

.....

(Address), ...

..... County, Pa.

Is the voluntary method sufficient?—All of these inspections that have been referred to thus far are voluntary on the part of the owner and are not made excepting upon his application and evidence that there is good reason to believe that the herd is actually infected. The question now arises as to whether this method is sufficiently far reaching; that is, whether it ensures the inspection of all herds that should be inspected and the removal of all tubercular animals that should be removed. While this is an important question, its value is somewhat lessened by the fact that the State Live Stock Sanitary Board is doing all of the work it can do with the funds at its disposal;

so, if more herds were reported for inspection, this would mean that a corresponding number of other herds reported for inspection would have to be kept waiting. As a matter of fact, the method that is now in operation is gradually but surely reaching and clearing up the worst infected and the most dangerous herds in the State. Usually the owners of such herds are led to appeal to the State by two motives, first through fear that tuberculosis may be distributed by the products of their herd and, second, through a desire to escape the unceasing losses caused by the ravages of tuberculosis among their cattle. If these motives are not sufficient to cause an inspection to be applied for, the herd owner is, if his herd is badly infected, usually impelled to seek the aid of the State Live Stock Sanitary Board when he finds that his animals and his dairy products do not find a ready market and that his neighbors frown upon the maintenance of a notoriously tubercular herd in their community.

Special regulations for advanced and udder cases.—All animals afflicted with advanced tuberculosis, or tuberculosis of the udder, are required by the regulations of the State Live Stock Sanitary Board to be placed in quarantine and the milk from such animals is not permitted to be sold or used. A clause in the Pure Food Law also prohibits the sale of milk from diseased cows and provides a penalty for so doing. If the owner of the herd has signed an application for the inspection of his entire herd, the appraisal and destruction of these advanced and udder cases may be carried out at the expense of the State and without waiting for the inspection of the remaining portion of the herd, because such animals are prolific distributors of disease germs and they should be gotten rid of as soon as possible, and the premises occupied by them disinfected. If the owner of such animals has not and will not apply for an inspection of his entire herd, the animals of the class described are held in strict quarantine until they are disposed of at the loss of the owner or until the inspection of the herd is applied for and the accompanying agreement is signed. In appraising such animals, their actual value and condition at the time of appraisement must be taken into consideration and it is usually deemed that they have lost all value excepting for fertilizing purposes, so that the amount of the appraisement is nominal.

Disinfection.—After the tubercular animals are removed from the herd, it is in all cases required that the premises shall be well disinfected and in accordance with the following rules for disinfection given in Circular No. 2:

Directions for Disinfecting Stables.

"*Disinfection as it is usually practiced in stables is misleading and worthless.* Disinfection is carried out for the purpose of destroying

disease producing germs and to be effectual, all of these germs must be destroyed. Disease germs are minute living bodies; they float in the atmosphere, are carried by water, food, manure and in fact by anything that has been in the vicinity of an animal suffering with a contagious disease.

"The germs of some diseases are very delicate and, after leaving the body of an afflicted animal they die within a short time, and in these cases it is not possible for them to spread very far. In other diseases, however, the germs are exceedingly resistant organisms; they can endure heat and extreme cold, they can live outside of the body for days or weeks, in some cases for months, and even years.

"Most of the disease producing germs do not multiply outside of the body, but a few of them do, and these can be propagated, under favorable conditions, almost indefinitely.

"Since these organisms are so minute and can be carried about in the air as dust, they may lodge in the smallest crevices and most remote portions of the stable and in places most difficult of access. Hence, it is very evident that the usual so-called disinfection, which consists in scattering a strong smelling substance about, cannot be efficient. When the disinfectant (an agent used to destroy disease producing germs) is scattered carelessly about on the floor of a stable, it may not cover more than but one-hundredth of the area upon which the germs are lodged. So that, in this case, but one per cent. of the stable is disinfected. *Disinfectants cannot destroy germs that they do not come in contact with*, and if but part of the germs are destroyed and the others are allowed to remain, the results of the whole operation will be disappointing.

Rules for Disinfection:

"*1. Permit the entrance of a plentiful amount of light.* Disease producing germs are destroyed by the direct rays of the sun within a short time. They are destroyed by less intense light more slowly but will live for long periods in dark places. So that one of the cheapest and best disinfectants is sun-light. There are numerous other advantages in having plenty of light in a cow stable that are not necessary to mention here.

"*2. Cleanse the stable thoroughly.* It has been stated already that disinfectants do not destroy germs that they do not come in contact with, and in order to permit the disinfectants used subsequently to come in contact with all the surfaces that may harbor disease producing germs, it is necessary that these surfaces should be uncovered by the removal of the dirt that has accumulated over them.

"The cleansing of the stable includes (a) removal of manure; (b) removal of piles of fodder; (c) sweeping the ceiling, walls and floor; (d) the removal of rotten wood work and loose boards, especially of the floor; (e) the removal of dried accumulations about mangers, floors and drains; (f) scrubbing the mangers, feed-boxes, stalls and partitions, which should be done with hot water and strong soap, lye or washing soda.

"*3. Apply chemical disinfectants.* After the stable has been treated as above recommended, it is ready for the application of chemical disinfectants. These are substances that poison germs. There are many of them. Some of them are far more efficient than others. One of the most active is bichloride of mercury or corrosive sublimate. This substance is poisonous and must be used with great care. Before it is applied, it must be dissolved in water, in the proportion of one part to one thousand. One ounce of corrosive sublimate dissolved in eight gallons of water makes a solution of the right strength. In making the solution, the corrosive sublimate should be dissolved in one gallon of hot water and then mixed with enough cold water to make eight gallons. The solution should be kept in a wooden tub or in an earthen crock. It corrodes metal. This liquid can be applied with a brush, sprinkling pot or spray pump and must be carried into every crevice or recess into which dust can enter.

"Another disinfectant that is good, but less efficient than the above, is chloride of lime, of which 1 pound should be dissolved in three gallons of water and applied in the same way. Carbolic acid mixed with water in the proportion of one to twenty parts, or one pint to two and one-half gallons of water is also efficient, and should be applied in the same manner as bichloride of mercury solution. *All things considered, carbolic acid is probably the best disinfectant for general use.*

"Sulphate of iron, commonly known as copperas, makes an excellent and cheap disinfectant for floors, gutters, drains, etc. It should be applied as a saturated solution. As much sulphate of iron should be dissolved in the water as possible, and this solution should be applied very freely with a sprinkling can, to the places that are to be disinfected with it. It is not poisonous and when applied in large quantities, is a good disinfectant. It is also of great utility in disinfecting mangers, feed boxes, etc., on account of its non-poisonous properties.

"*4. Whitewash.* Although whitewash is not an active disinfectant, in the usual meaning of this term, it is an excellent purifier, and should in all cases be used in stables after they have been thoroughly cleansed and disinfected with other agents. If chloride of lime is

added to whitewash in the proportion of one pound to three gallons of water, the value of this application is greatly increased. It is advisable to whitewash cow stables frequently, at least once in six months and better once every three months. Hot whitewash for this purpose is better than cold.

"*5. Allow the stable to remain perfectly empty, if possible, for several weeks.* Of course, this cannot be done in all cases, but where it is possible it is well to allow a greater opportunity for the death of disease producing germs that may have escaped the disinfectant applications.

"There are some badly constructed stables that it is almost impossible to disinfect, because cisterns, wells, cesspools, root cellars, spaces in the walls, floors, etc., cannot be reached properly. In these cases it is sometimes necessary to vacate the premises for a long period, or, if they have but little value, burn them down. Where the floor of the stable is made of earth it is well to dig it out to a depth of about six inches, or as far as liquids have penetrated, and refill the excavation with fresh earth.

"The litter, old wood work, etc., removed from infected stables should be burned.

"Leonard Pearson,
"State Veterinarian."

Precautions after inspection.—After a herd has been inspected, it is re-inspected within a year, if it is found to be badly infected upon the first inspection, and, if necessary, a third or even a fourth inspection will be made. The precautions and measures that the owner agrees to observe after the inspection has been made at the expense of the State are the following:

Circular No. 3.

"Precautions and Measures to Be Observed to Prevent the Reintroduction and Redevelopment of Tuberculosis in Inspected Herds.

"After the herd has been inspected and tested with tuberculin and the tubercular animals disposed of in accordance with the rules and regulations of the State Live Stock Sanitary Board, the premises occupied by the diseased animals must be very thoroughly disinfected in accordance with the directions in Circular No. 2 of this Board. It is assumed that cattle passed by the inspector—the cattle that show no physical signs of tuberculosis and do not respond to the tuberculin test—are free from tuberculosis and if they are protected from all sources of infection, they will remain free from this disease in all but a few cases, in which the disease is incubating or is latant at the time of the first inspection and test.

"The three principal ways in which tuberculosis is carried into the body are:

A. With the air.

B. With the food or water.

C. Through the skin or mucous membranes.

"All of these methods of infection should be guarded against most carefully and in order that they may be avoided, the following measures are recommended:

"1. The cattle should be watched very closely and upon the first indication of tuberculosis, the suspected animal should be removed from the herd and placed where its products and the things that have been in its immediate vicinity cannot come in contact with healthy animals, and the place occupied by it in the stable should be disinfected.

"2. It is well to subject the entire herd to the tuberculin test six to twelve months after the first inspection and if it should be found that an infected animal, or a source of infection had escaped the first inspection and disinfection, the condition can in this way be recognized before extensive injury has resulted.

"3. Additions to the herd should be purchased subject to one of the following conditions: (a) A report from a competent veterinarian showing that the animal has been tested with tuberculin and found to be free from tuberculosis a short time before the sale, or (b) full information covering the herd from which the animal is procured. In the latter case, it should be known that the herd has never been infected with tuberculosis, or that its members have been inspected with tuberculin and found free from disease.

"Freedom from tuberculosis is indicated but not proven by a general thrifty appearance, good flesh, bright coat and bright eye, lively temperament and absence of cough. If the animal has been well fed but is found in an unthrifty condition, it is suspicious. Cattle from unknown sources should not be purchased without a guarantee that they are healthy, and since it is absolutely impossible for any one, however experienced or wise, to discover a large percentage of cases of tuberculosis without the tuberculin test, notwithstanding the fact that many of them may be in a condition which renders them dangerous to their associates, the guarantee of health should be based on accurate and reliable information as indicated above. It should not be forgotten that a large proportion (probably nine-tenths) of all herds that are infected with tuberculosis, were contaminated by cattle that were thought to be sound when they were purchased.

"4. The cow stable should be well lighted. Many stables are deficient in this respect and as it is a serious matter, it should be remedied. The value of light lies in the fact that it restricts the activity of

and destroys disease producing germs, and it exposes dirt. Moreover, cows kept in a dark place usually become unthrifty and do not have such a high degree of resistance to disease as is possessed by those kept in the light. Dark stables are apt to be damp. Thus it is seen that the value of light is manifold and windows should be abundant.

"5. The stables should be kept clean. Manure, litter and dirt must not be allowed to accumulate, because these collections furnish places for the preservation and growth of disease germs and also serve to contaminate the atmosphere by the odors and gases which they emit.

"6. The stable should be kept dry. The fluid evacuations should be absorbed with dry litter or should be drained into a receptacle outside of the stable. If the walls are damp, measures should be taken to correct the fault, because a damp wall leads to an unwholesome degree of moisture of the atmosphere, furnishes a favorable surface for the preservation and growth of germs, leads to contamination of the air with their products, and favors chilling. Sometimes it is necessary to dig the earth away from the wall outside of the stable and it may be necessary to build a retaining wall a short distance from the stable wall in order to keep the earth back and allow a space for the free circulation of air. Damp walls are sometimes caused by leaky roofs or too short overhangs.

"7. The air in the stable must be kept pure. The observance of all the measures recommended above will greatly influence this factor, but, as air is constantly being used by the animals in the stable, it is necessary to provide for ample ventilation for a renewal of the supply. The arrangements for ventilating should be so planned that air may be introduced in sufficient quantity but not as a draught that will come in contact with any of the animals. Air should be removed from the stable near the floor.

"8. Cleanse the stable with especial care and whitewash it at least once in six months.

"9. Do not feed skim milk from creameries to calves, without previous sterilization by boiling. This is essential for many cases have been recorded and several have come to the personal experience of the State Veterinarian in which a tuberculous herd supplying milk to a creamery with a large number of patrons, who used the skim milk as food for calves and pigs, caused the development of tuberculosis on a number of farms in the vicinity.

"10. Do not purchase or use fodder that has been stored above a stable occupied by tubercular cattle. The germs of tuberculosis float in the air as dust and become mixed with fodder stored within their reach, rendering it dangerous to feed to cattle.

"11. Healthy cattle should not be allowed to drink from a watering trough habitually used by tubercular cattle, nor should they be allowed to associate with them in the pasture or elsewhere.

"12. The offspring of tubercular parents, or calves from a tuberculous herd, should not be allowed to mix with the herd until they have been tested with tuberculin and found free from disease.

"13. The bull should be perfectly healthy and should not be patronized if he has been used in a tuberculous herd, unless his freedom from tuberculosis has been proven by the application of the tuberculin test.

"14. It is not well to allow a consumptive to work about cattle or in the dairy, in any capacity.

"Leonard Pearson,
"State Veterinarian."

The inspection of cows from other States.—The only compulsory use of tuberculin in Pennsylvania is in the inspection of dairy cows and cattle for breeding purposes coming from other states. Inspection of these animals is required by the act of May 25, 1897. This act and the rules for enforcing it follow.

AN ACT

To protect the health of the domestic animals of the Commonwealth of Pennsylvania.

Section 1. Be it enacted, etc., That the importation of dairy cows and neat cattle for breeding purposes into the Commonwealth of Pennsylvania is hereby prohibited, excepting when such cows and neat cattle are accompanied by a certificate from an inspector, whose competency and reliability are certified to by the authorities charged with the control of the disease of domestic animals in the state from whence the cattle came, certifying that they have been examined and subjected to the tuberculin test and are free from disease.

Section 2. That in lieu of an inspection certificate as above required, the cattle may be detained at suitable stock yards nearest to the state line on the railroad over which they are shipped, and there examined at the expense of the owner, or cattle as above specified from points outside of the State may, under such restrictions as may be provided by the State Live Stock Sanitary Board, be shipped in quarantine to their destination in Pennsylvania, there to remain in quarantine until properly examined at the expense of the owner, and released by the State Live Stock Sanitary Board.

Section 3. The State Live Stock Sanitary Board is hereby authorized and empowered to prohibit the importation of domestic animals into the Commonwealth of Pennsylvania, whenever in their judgment such measures may be necessary for the proper protection of the health of the domestic animals of the Commonwealth, and to make and enforce rules and regulations governing such traffic as may from time to time be required.

Section 4. That any person, firm or corporate body violating the provisions of this act, shall be deemed guilty of a misdemeanor, and upon conviction shall,

in the proper court of the county in which such cattle are sold, offered for sale, delivered to a purchaser, or in which such cattle may be detained in transit, for each offense, forfeit and pay a fine of not less than fifty dollars or more than one hundred dollars, or be punished by imprisonment for not less than ten days, and not exceeding thirty days, either or both, at the discretion of the court. Such person, firm or corporate body shall be liable for the full amount of the damages that may result from the violation of this act.

Section 5. The State Live Stock Sanitary Board is hereby charged with the enforcement of this act, and is authorized to see that its provisions are obeyed, and to make, from time to time, such rules and regulations as may be necessary and proper for its enforcement.

Section 6. That this act shall go into effect January first, one thousand eight hundred and ninety-eight.

Approved by the Governor—May 26, 1897.

Rules for the enforcement of the act of May 26, 1897.

Dairy cows and neat cattle for breeding purposes may be brought into Pennsylvania from other states only in accordance with one of the three following provisions:

1. The cattle may be examined and tested with tuberculin in the state from whence they come by an inspector whose competency and reliability are certified to by the authorities charged with the control of the disease in that state. Special blanks for reporting upon such examinations will be furnished by the State Live Stock Sanitary Board upon application. Cattle thus examined, found to be free from disease and brought into Pennsylvania, shall remain in the possession of the person or persons who own them when brought into Pennsylvania until the inspection reports have been approved by a member of the State Live Stock Sanitary Board or by an agent authorized to approve such reports. After such approval, the cattle can be disposed of without restriction.

2. Dairy cows and neat cattle for breeding purposes may, if shippers so elect, be examined and tested with tuberculin at suitable stock yards nearest to the state line on the railroad over which they are shipped. Such examinations are to be made by inspectors approved by this Board and at the expense of the owner of the cattle.

Cattle so inspected shall be marked with a suitable metal tag or shall be accurately described so that they can be reliably identified, and a report on the examination and test, with directions for identification, shall be submitted without delay to this Board.

3. Dairy cows and neat cattle for breeding purposes may be brought into Pennsylvania without previous examination only under the following conditions:

A. Notification to the State Live Stock Sanitary Board that it is proposed to bring certain dairy cows or neat cattle for breeding purposes into this State. Such notice must be accompanied by the number and a full and accurate description of the cattle, the names and addresses of the owner and consignee, the date upon which they are to be brought into the State, the route over which they are to be driven or shipped, and the destination.

A blank form to use in rendering this report will be sent upon application to the State Live Stock Sanitary Board.

B. Such cattle shall remain in strict quarantine during transit and after they have arrived at their destination, until they have been examined and tested with tuberculin by an inspector approved by this Board. Under this quarantine it is required that the cattle shall be kept apart from other cattle, that they shall remain in the possession of the person or persons who bring them into this State and that their milk shall not be sold or used without previous sterilization by boiling.

Dairy cows or neat cattle for breeding purposes brought into Pennsylvania under this provision, that are found upon examination or test to be tubercular, shall be strictly isolated and quarantined, their milk cannot be used for any purpose whatever without previous sterilization by boiling, and they shall not be moved to other premises excepting for slaughter. No compensation shall be allowed for such cattle. Approved by the State Live Stock Sanitary Board at Harrisburg, Pa., November 5, 1897.

It will be seen that these tests can be made outside of the State by an inspector approved as regards competency and reliability, by the authorities charged with the control of the diseases of animals in that State. Or, secondly, if the owner prefers, the cattle may be detained at suitable stock yards in transit, and tested there. Or, thirdly, the cattle may be shipped on permit to their destination in Pennsylvania and there examined with tuberculin by an inspector approved by the Live Stock Sanitary Board of this State and paid by the owner of the cattle.

The form of permit used is the following:

State Live Stock Sanitary Board.

Record Book

Number .....

Harrisburg, Pa., ... 190..

This will permit Mr. .....
to ship .....
.....
cattle (dairy cows or cattle for breeding purposes) from .....
..... to ..... Pennsylvania without examination until arrival at destination. These cattle will remain in quarantine until arrival at destination and test with tuberculin by ..... who is authorized to release them if found free from disease. This permit will expire ..... 190.., and is not valid until a description of each animal in the lot is written below.

This permit is to be taken up by said inspector and returned to the Secretary of the State Live Stock Sanitary Board.

.....
State Veterinarian.

The following is to be filled in and signed by the shipper:

ANIMAL Cow, bull, heifer, calf.)	BREED.	AGE Approximate.)	COLOR AND MARKINGS.	EAR TAG NUMBER (if any.)

(Shipper signs here), ...

(Address), ...

.....

Tuberculin for all of these tests is furnished without charge by the Board, but the inspectors are, in all cases, compensated by the shipper or owner of the cattle. This law has been in operation since January 1st, 1898, and under it about 50,000 cattle have been examined. A considerable proportion of these have been examined before shipment into Pennsylvania. Of those shipped into Pennsylvania and examined at their destination, about 320 were condemned. After three years' experience with this law cattle shippers have been able to gain a good deal of information as to where tuberculosis is a prevalent disease, and such localities are now avoided by them. Therefore, the cattle shipped into Pennsylvania at the present time are more carefully selected than ever before both as to the locality from which they originate and as to their individuality.

The need for this inspection requirement is indicated by the fact that tuberculosis is most prevalent in those parts of Pennsylvania into which the greatest number of cattle are shipped. The fact that large numbers of animals have been brought into these sections, means that there has been much opportunity for contamination and it is evident from the statistics of inspections made in such localities that a large amount of contamination has actually occurred. The cattle in the cattle producing districts of Pennsylvania, the localities from which cattle are sent out and few are brought in, are comparatively free from tuberculosis. By means of this law, it is possible for farmers who have eradicated tuberculosis from their herds, to restock with animals they know to be in health.

The dangers to which purchasers are exposed where they are without the protection afforded by this law, is indicated by the fact that cattle dealers in other states have repeatedly endeavored to

purchase from farmers in Pennsylvania animals that have been condemned as tubercular. They said that they could readily take them to states without a law requiring the inspection of incoming cattle and there dispose of them. The writer has personal knowledge of a number of herds in adjoining states that have been freed from tuberculosis by selling the tubercular animals. Members of such herds have many times been prevented from coming into Pennsylvania by the application of this inspection law. Indeed, it is a common and well known practice of certain breeders to sell tubercular animals that they are afraid to keep in their own herds. Complete evidence to support this statement is available. Several large herds have been sold recently because they were so permeated with tuberculosis that they could no longer be maintained profitably.

The danger of infection from such outside sources was first appreciated by the New England States. At this time, however, the appreciation of the danger is general and the tuberculin test is required to be applied to cattle imported into the United States from Europe and Canada, to cattle imported by Canada from Europe and the United States and is also required by seventeen separate states of this country.

In Europe almost every country has this requirement, except Great Britain, where foreign cattle are absolutely excluded excepting those that are killed on the landing docks within five days after arrival.

General Administration and Results.—The field work of the State Live Stock Sanitary Board is under the supervision of the State Veterinarian and is carried out by him with the aid of veterinary practitioners of the State who are employed for special work as their services are required. For herd tests, veterinarians are compensated at the rate of $5 per day and proportionate sums for parts of days. As this rate of compensation is low, it has in some cases been difficult to secure the services of the best veterinarians. It is, however, a rule to which there are few exceptions, that the veterinarians of the State take a patriotic view of the matter and are willing to give the State the benefit of their best skill. It is thought that there has been advantage in having inspections made by veterinarians residing and practicing in the immediate locality. By engaging the services of such veterinarians in this work, they become thoroughly familiar with and are interested in the suppression of tuberculosis in the herds in their community, and if the herd owner has reason subsequently to fear that something is wrong with his cattle, he is able, without going far, to consult an expert who is thoroughly familiar with the conditions surrounding the case. Moreover, after a veterinarian has eradicated tuberculosis from a herd, so far as possible, he is likely

to be interested in the maintenance of the health of that herd and will be able to do more for it if near by than would be possible at a greater distance.

Another fact that is believed to have had a favorable influence on the progress of the work directed against tuberculosis in Pennsylvania, is the manner in which the post-mortem examinations have been made. It has been stated above that nearly all owners of tubercular cattle have desired to accept the indemnity offered by the state and have the cattle destroyed. In some states it has been the practice to ship cattle to be killed to a city abattoir or rendering works where they might be conveniently examined, and their carcasses used for making fertilizer. The amounts received for carcasses for this purpose are not great and if the animals must be shipped far, nearly all of the income is taken up in freight charges. It is possible, however, to effect a small saving where full carloads can be shipped. This system has not been generally followed in Pennsylvania because it was deemed important to instruct owners of animals in regard to tuberculosis; and to permit them to see post-mortem examinations, is a most effective way of imparting information in regard to the disease.

The statement has been made so often by persons not familiar with the facts in regard to tuberculosis, but who have not hesitated, nevertheless, to make the most positive statements, that an animal cannot be dangerously tubercular without showing well marked symptoms. In consequence of this, and as a result also of a most natural belief that an animal that looks well must be well, there were people every where who could not be convinced that an apparently sound animal—an animal in good flesh, with a good appetite and giving a good flow of milk—could be tubercular to a material degree, even though it had responded to the tuberculin test and even though other symptoms of tuberculosis could be detected by the discerning veterinarian. Where this view prevails, there is no way to teach the facts that must be impressed, if tuberculosis is to be eradicated by a state, other than to give ocular demonstration. When a man has seen a herd of tubercular cattle alive and has seen them killed and witnessed the alterations produced by the disease, he is willing to admit that an animal can be tubercular to a dangerous degree without showing symptoms. Of course, this same information can be derived by the examination of animals killed for food. It is not an uncommon thing in large abattoirs to find animals apparently in the pink of condition, containing widespread and extensive lesions of tuberculosis. But this source of information is not generally available.

As a striking proof of the value of the information imparted in

the manner just indicated, it may be said that the Live Stock Sanitary Board is applied to for the greatest number of inspections in districts in which the greatest number of demonstrations of this kind have been held. As an illustration of this: There is a community in one of the eastern counties of the State in which there were many farmers who were opposed to any inspections of herds for the purpose of repressing tuberculosis. They did not believe that the disease was prevalent enough to be of economic importance and some of them claimed that it was of little or no importance from the standpoint of public health. Furthermore, they had been prejudiced against the tuberculin test by some of the agricultural papers. No inspections were applied for in this district until, a few months ago, the owner of a herd of twelve cows had lost three of his animals by death from tuberculosis. He thereupon applied for an inspection of the remaining members of his herd, and much to his surprise, all of the animals reacted to the test. It was arranged to have them appraised and killed. The matter excited a great deal of interest in the neighborhood and as many as two hundred farmers came to see the post-mortem examinations. They were so impressed with what they saw that a flood of applications for herd tests came to the Live Stock Sanitary Board from that neighborhood and as the inspections could not be made as rapidly as was desired many cattle owners had their cattle tested at their own expense. This illustrates the fact, that has been reiterated in this report, that the farmers of Pennsylvania want healthy herds. The farmer who knows that his herd is infected with tuberculosis and who does not apply to the State for assistance in checking the infection, is the exception. Therefore, what is needed is to bring the facts in regard to tuberculosis to the attention of cattle owners and no more effective way of doing this has been devised than to make it possible for them to witness post-mortem examinations on tubercular cattle.

Sometimes dairymen do not wish to have their tubercular animals utilized in this public way. They desire the slaughter to be conducted privately. Such requests are always observed. Where many animals are to be destroyed and where the facilities are poor, and especially during severe weather, it is most convenient to ship condemned cattle to a fertilizer establishment. The expense of shipment is, in this case, taken out by the proprietor of the fertilizer works, of the amount allowed by him for the cattle, and the balance is paid to the owner.

Another result of the recognition of the facts in regard to tuberculosis has been the lessening of the tendency, that was so extremely prevalent, to exaggerate or minimize the facts in regard to this disease. At one time it was extremely difficult to find articles or to

hear discussions on this disease in which the dangers were not grossly exaggerated or the importance underestimated.

During the period of operation of the State Live Stock Sanitary Board, 44,801 cattle have been examined and tested with tuberculin at the expense of the State and of these 5,869 have been condemned, destroyed and paid for. The payments have averaged about $23.00 per head. An attempt has always been made to select the most extensively diseased herds for inspection. During the first eighteen months of the work, that is up to June 1, 1897, 9,108 cattle were tested and of these 1,839 were condemned. The percentage of tuberculosis, therefore, was 20.39. From June 1, 1897, to June 1, 1899, 16,687 cattle were examined and 2,116 were condemned, making the percentage of tuberculosis 12.67. The fact should not be lost sight of in this connection that these figures represent the percentage of infection among the most extensively infected herds in Pennsylvania. Since June, 1899, very few herds have been examined where there was not the strongest reason to believe that they were infected, and, indeed, extensively infected, before the inspection was made. At present a good many herds are being examined at the expense of their owners and the tubercular animals are being taken over by the State. (Under the arrangement afforded by application form C. See page 184.)

At least as many herds have been examined by their owners as have been examined by the State, and only a limited portion of the tubercular cattle found in these herds are appraised and paid for by the State. Some of them are no doubt sold to drovers and disposed of to other farmers where they may have an opportunity to spread disease and others are sold to butchers and turned into food for man. Still others are destroyed by their owners and no compensation is asked for. It should not be inferred that in these inspections made at private expense, anything like as many tubercular cattle are found as in inspections made by the State, because the inspections made privately frequently, if not usually, reveal nearly the entire herd to be free from infection.

The applications for herd tests are from three to four times as numerous as the inspections made by the State. Some applications are not accompanied by evidence that tuberculosis exists in the herd; others are accompanied by insufficient evidence. The applications are sifted very carefully; as many inspections are made as can be paid for, and it is the constant endeavor to select for inspection herds that are most likely to contain diseased animals.

All of this shows that knowledge of tuberculosis and the desire to eradicate it from herds, are developing at a rapid rate in Pennsylvania. This tendency is seen not only in requests for inspection

but also in improvements in stables, increased care in purchasing additions to herds and by the increase of breeding as opposed to the purchase of dairy cows.

An exact census of tubercular cattle in Pennsylvania has never been made. Therefore, it is impossible to say how much tuberculosis there was in the State and to compare that amount with the undetermined amount that exists at this time. All evidence on this point must be somewhat indirect and circumstantial. There is, however, conclusive evidence to the effect that tuberculosis is very much less prevalent among the cattle of Pennsylvania than it was when the work of the State Live Stock Sanitary Board started in 1896. For example, nearly all of the worn-out dairy cows from the herds in the vicinity of Philadelphia are shipped to that city for slaughter. These cattle are inspected more or less thoroughly by the city meat inspectors. The inspectors visiting or stationed at the Philadelphia slaughter houses, are impressed by the fact that there is very much less tuberculosis among cows than was the case three or four years ago. The practicing veterinarians of the State are in constant contact with herds and are at all times informed as to the general health of the cattle within their fields of practice. The veterinarians testify almost uniformly that tuberculosis is gradually but surely being repressed in the herds with which they come in contact. Not one-half as many tubercular cattle are found in the inspections made by the State Live Stock Sanitary Board as at the beginning of its work. Two hundred correspondents report that the average prevalence of tuberculosis is reduced one-half in four years. In the dairy counties in the northeastern part of the State, where there was at one time considerable tuberculosis, thousands of cattle have been tested during the past two years without finding one per cent. of tubercular animals. It is in these counties that the Live Stock Sanitary Board has done the greatest amount of work, and about 550 tubercular cattle have been removed from them.

The increased desire of herd owners to purchase cows known to be free from tuberculosis, is shown by the fact that many breeders of pure bred cattle guarantee the animals they sell to be free from tuberculosis as established by tuberculin test. At the principle auction sales of cattle of the better class in the eastern states, the tuberculin test is required by purchasers. Moreover, many dealers in ordinary dairy cows, find it to their advantage to have them tested with tuberculin so that they may be able to guarantee all cattle they sell to be free from disease.

Since it is admitted by all who have carefully studied the subject, that tuberculosis can never be eradicated from herds without the co-operation of herd owners and an earnest desire on their part that the disease shall be suppressed, *the fact that the herd owners of*

Pennsylvania are so earnest in this matter constitutes a most hopeful and encouraging sign, and means that the disease will be suppressed.

The work that has been and is being done has the effect of not only removing diseased and dangerous animals, but, so far as possible, it insures a permanent result for the money expended and, in addition, it has an educational value that must be looked upon as of great importance. There can be no doubt as to the urgent sanitary grounds for the removal from herds and from the food supply of all cattle afflicted with advanced or udder tuberculosis. But this work alone would continue indefinitely if action were not taken to prevent the disease so that these excessively dangerously diseased animals would not be continually produced. Nor would the removal of these animals alone check the economic losses from which the farmer suffers. It is for the purpose of striking at the root of the evil that the other measures desribed above are designed.

SUPPLEMENT TO CHAPTER X.

Reports from Herd Owners on their Losses from Tuberculosis and the Condition of Inspected Herds.

In order to get from herd owners important facts in regard to the condition of herds that were tested some time ago by the State Live Stock Sanitary Board, the questions that follow were prepared and sent out to owners whose herds were tested during the years 1896 and 1897. It was considered that reports dating back to that time would be more valuable than reports on herds tested recently. All of the answers that have been received, are printed on the following pages. It is believed that the information contained in them, is of value as indicating, in some degree, the permanency of the work that has been done and also as throwing light upon the effect of tuberculin on cattle not tubercular and the care with which the precautions and measures recommended by the State Live Stock Sanitary Board to prevent the reinfection of herds have been observed.

The questions were:

1. When was your herd tested?
2. How many animals did you have at that time?
3. How many were condemned as tubercular?
4. How many cattle have you at present?
5. How many have you lost since the test?
6. Of what disease did they die?
7. What is the condition of the cows in your herd now as compared with their condition before they were tested?
8. What is the milk product of your herd now as compared to the yield before the test?
9. What is the extent of your loss from tuberculosis?
10. What is your opinion as to the extent of the prevalence of tuberculosis among cattle in your vicinity?
11. Do you know in what manner your herd became infected with tuberculosis?
12. To what extent have your premises been changed and improved since the herd was tested?

The numbers in the answers refer to the number of the questions.

(1) 1. December, 1896. 2. About 15. 3. None. 4. Sixteen. 5. None. 7. About the same. 8. Slightly improved. 9. One cow summer of 1896, worth about $30. 10. I do not know of any. 11. The cow that was infected was bought from a dealer, the balance of the herd were free from disease.

(2) 1. February, 1897. 2. Fifteen. 3. One. 4. Sixteen. 5. None. 7. They are all in good condition. 8. About the same. 9. $47.50. 11. I bought the cow out of a drove.

(3) 1. January, 1897. 2. Twenty-five. 3. Fifteen. 4. Twenty-nine. 5. None. 7. Now in thrifty condition, which before they were not. 8. Regular; before it was irregular. 9. Two hundred dollars. 10. That there is a good bit more of it than the owners are aware of. 11. It came in a herd of thoroughbred Guernseys we bought. 12. Thoroughly cleaned; our stables are sprinkled with slaked lime once a week.

(4) 1. March, 1896. 3. Forty-three. 4. None. 9. Over 75 head. 11. Do not; think from purchase of stock.

(5) 1. December, 1897. 2. Ten. 3. One. 4. Ten. 5. None. 7. Dry before test, now fresh; they are in very good condition. 8. A great deal better. 9. Twelve hundred dollars; I lost about 30 head at two different times; one year ago I lost 17, four years ago I lost 13; 13 I never got anything for. 10. I think there is a good bit of it. 11. Six years ago I took a farm on halves where tuberculosis existed, although I was in ignorance of this at the time. 12. Have been thoroughly whitewashed and disinfected and try to give plenty of fresh air.

(6) 1. 1897. 2. Two. 3. None. 4. Two. 5. None. 7. The same. 8. Just the same. 9. None lately. 10. Know of none at the present time. 11. Was affected when I bought her. 12. I have renovated my stables.

(7) 1. December, 1895. 2. Twelve. 3. Not any. 4. Fourteen. 5. Not any. 7. About the same. 8. About the same. 10. To the best of my knowledge there is no tuberculosis in the neighborhood. 11. I do not.

(8) 1. December, 1896. 2. Ten. 3. Not any. 4. Eleven. 5. One. 6. No disease, strangled in the stall. 7. The same. 8. No difference. 10. I do not know of any cases in this vicinity at present. 11. There was no infection found among them.

(9) 1. February 6, 1897. 2. Twelve. 3. Four. 4. Seven. 5. Not any. 7. Much better. 8. Much better. 9. $220. 10. A large number have been affected. 11. I do not know.

(10) 1. October, 1896. 2. Thirty-eight. 3. Nineteen. 4. Thirty-one. 5. One. 6. Calving. 7. Very good. 8. Much better. 9.

$1,495.00. 10. That many would not stand the test. 11. Do not. 12. Barns cleaner and better ventilated.

(13) 1. July, 1896. 2. One. 3. One. 5. One killed at time of test. 9. One cow. 10. It seems to be on the increase, particularly among thoroughbred or high grade cows, not so much among those that have been shipped into this neighborhood as those raised here. 11. I do not.

(14) 1. October, 1896. 2. Seven. 3. Two. 4. Five. 5. None. 8. Cannot tell definitely, but it is fully as good. 9. Three head, one dying from it and two condemned and slaughtered. 10. Rather prevalent. 11. From a cow bought of a farmer in Chester county.

(15) 1. March, 1897. 2. Five cows. 3. Not any. 4. Three cows, two heifers. 5. Not any. 8. About the same. 10. There have been a number of cattle killed that were affected with tuberculosis.

(16) 1. December, 1897. 2. One. 3. None. 4. Two. 5. One. 6 Milk fever. 7. Fair class. 8. Before 12 quarts, after test the same. 9. None. 10. Do not know of any. 11. Do not know.

(17) 1. January, 1897. 2. Thirty. 3. Nine. 5. One. 6. Inflammation following abortion. 7. Somewhat better. 8. We have more cows and more milk. 9. A great deal. 10. I do not hear of many lately; I think there is less of it. 11. From a cow that a tenant brought here. 12. We did everything we could to clean away everything of the disease.

(18) 1. Fall of 1896. 2. Sixteen. 3. Two. 4. Fifteen. 5. None. 7. Somewhat better. 8. About the same. 9. $260. 10. They seem healthy as far as I know. 11. I do not. 12. Keep premises cleaned up and spread bleach around.

(19) 1. February, 1897. 2. Twelve. 3. Four. 4. Eight. 5. None. 7. Much better. 8. Much better. 9. $260. 10. To some extent. 11. Do not know. 12. To some extent.

(20) 1. June, 1897. 2. Twelve. 3. Two. 4. Ten. 5. One. 6. Milk fever. 7. I see no difference. 8. The same. 9. Two cows worth $80, received $50 from the State. 10. Diminishing. 11. Bought two cows from neighbor, who subsequently had his herd tested by the State. 12. Thorough cleaning and disinfection.

(21) 1. December, 1896. 2. Seven. 3. None. 4. Seven. 5. Lost none. 7. There seems no difference. 8. Running about the same. 10. I think it right to have the cows tested.

(22) 1. December, 1897. 2. Ten. 3. Not any. 4. Eight head. 5. Not any. 6. No disease. 7. About the same. 8. Its yield is about the same. 10. My opinion is that the inspection is a very good thing. 11. Buying a western cow.

(23) 1. About last of April, 1897. 2. Two. 3. None. 5. None.

(24) 1. May 30, 1896. 2. Four. 3. One. 4. Two. 5. None. 7. All right now. 8. Good. 9. $25.00. 10. Do not know of any now.

11. Bought the cow of a dealer. 12. Disinfected and stables whitewashed.

(25) 1. April, 1896. 2. Three. 3. Three. 4. Four. 5. Not any. 7. Good. 8. Good. 9. $85.00. 10. That there are few if any at the present time. 11. I do not. 12. I did not have cattle in my stable for six months after my cows were killed. I filled the stable with new ground, scrubbed the mangers with carbolic acid, and whitewashed.

(26) 1. June, 1896. 2. Four. 3. One. 4. Three. 5. None. 7. They all seem healthy as far as we know. 9. I cannot tell, as I have only one heifer milking at present. She was a young fresh cow, valued at $40. We received $25 from the State. 11. I do not know, as we bought her of milkman and he has never had any cattle have the disease. 12. Our stable has been cleaned and whitewashed and carbolic acid put around the stables.

(27) 1. November, 1896. 2. Nineteen. 3. Twelve. 4. Seventeen. 7. The ones I had tested are doing finely; I bought six more and they are not in good condition. 9. Seven hundred dollars. 10. I think there is plenty of the disease. 11. I do not. I have been told by expert breeders that I bred it in interbreeding. I had 18 cows I bred. I thought I had a fine herd, all full bred but unregistered.

(28) 1. July, 1896. 2. Sixteen. 3. Three. 4. Ten. 5. Not any. 7. I think better. 8. About the same. 11. An old cow bought out of a drove.

(29) 1. 1896. 2. Fourteen. 3. One. 4. Twenty. 5. None. 7. Good. 8. Good. 9. $55. 10. Not so much of it. 11. I do not. 12. Filled up and whitewashed.

(30) 1. Summer, 1896. 2. Four. 3. One. 4. Three cows. 5. None. 7. About the same. 8. Same in quantity, but better quality. 9. $20. 10. To the best of my knowledge there is no tuberculosis in vicinity. 11. By purchasing a drove cow from western Pennsylvania.

(31) 1. August, 1896. 2. Twenty. 3. Eighteen. 4. Fifteen. 5. None. 7. Not so good (all new cows). 8. Fifty per cent. less. 9. $300. 10. I think there are some cases not reported, but not of large extent. 11. From buying cows from dealers. 12. Everything cleaned out of the stables, filled in with fresh earth and thoroughly whitewashed. No other cattle allowed in for over two months.

I think there are many cows that are slightly affected with tuberculosis and in time will develop in many cases. The only way, in my opinion, to get rid of the disease is to have a law passed not allowing any cattle to be sold for breeding purposes unless tested under a penalty. I am satisfied there has been a number offered to me since I lost my herd that were affected and were sold on that account, and from that cause the disease is spread and still lingers in many herds.

(32) 1. February, 1897. 2. Fifteen. 3. One. 4. Sixteen. 5. None. 7. They are all in good condition. 8. About the same. 9. $47.50. 9. About the same. 11. I bought the cow out of a drove.

(33) 1. November, 1896. 2. One. 3. One. 4. One. 5. None. 7. Good. 10. Good. 11. By pasturing with a neighbor's cow afflicted with the disease. 12. Stables covered with new earth, chloride of lime and whitewashed.

(34) 1. Spring, 1897. 2. Fourteen. 3. One. 4. Fifteen. 5. None. 7. About the same. 8. About the same. 9. Twenty-five dollars. 10. Cannot say. 11. Do not.

(35) 1. February, 1897. 2. Twenty-one. 3. Fourteen. 4. Fifteen. 5. Two. 6. The first cow lost was one tested; she went within one-fifth of condemning point. He left her and in a few weeks after I disposed of her and made no examination, feeling satisfied of the cause. The other cow was purchased by my landlord in March following the inspection. She was never tested, but showed symptoms of the disease and it developed itself so fully that I killed her and opened her, finding lungs a mass of corruption; also the intestines and throat were diseased. 7. Our herd seems to be in good condition. 8. Those that were tested and not condemned are milking very well. 9. Our cows that time would have averaged us $40 a head. We received $25. 10. I think there are a few herds in the neighborhood that are affected. 11. By a cow that was bought and brought into the herd. 12. Thoroughly cleaned, whitewashed and disinfected liberally.

(36) 1. November, 1896. 2. Eighteen. 3. One. 4. Twenty. 5. None. 7. Favorable. 8. Equally good. 9. $50. 10. Do not know of any. 11. Cows bought from drovers.

(37) 1. September, 1896. 2. Seventeen. 3. Not any. 4. Sixteen. 5. Not any. 7. See no difference. 8. See no difference. 9. Not any. 10. Have no reason to think there is any.

(38) 1. April, 1897. 2. Eight. 3. Two. 4. Seven. 5. One died, one slaughtered. 6. Inflammation of kidneys and bladder. 7. Considering result of both tests which exhibited no symptoms of disease, cows are apparently in good health. 8. In March before the test the quantity was 1,284 pounds for March and after first test, which was in April, there was considerable increase in quantity of milk. 10. My opinion is that there is more loss of stock each succeeding year than is reported and that the disease is on the increase, judging from the amount of stock infected and killed. 11. Do not know, otherwise than being in an infected community, have been raising my own stock. The two cows affected were mother and daughter of Guernsey breed from registered stock.

(39) 1. April, 1896. 2. One. 3. One. 4. Two. 5. None. 7. My cows are in good condition now. 8. I cannot say as my cow is dry.

9. I held the cow at $75. She was full Jersey breed. 10. I do not hear of any. 11. I do not.

(40) September, 1896. 2. One. 3. One. 4. Two. 5. None. 7. Perfect. 9. $40. 10. Have not heard of any for a year or more. 11. No. 12. New stabling and disinfected.

(41) 1. March, 1897. 2. Eight. 3. One. 4. Five. 5. None. 7. The same. 8. Not so good; my barn burned last autumn and I have no good accommodations. 9. $25. 10. Do not know of any. 11. Do not. 12. Thoroughly renovated, everything burnt up but the well of water.

(42) 1. Spring of 1897. 2. Nine. 3. Not any. 4. Nine. 5. None. 7. In better condition. 8. Product good. 10. Very few.

(43) 1. October 15, 1897. 2. Seventy. 3. Four. 4. Seventy-one. 5. None. 7. About the same. 8. Can see no change. The killing reduced the milk product but we have heifers in milk in their stead. 9. $355. 10. Do not thing there is much. 11. Bought affected Guernseys from New York and affected Jerseys from Swarthmore, Pa. 12. All manure, bedding, etc., removed, stables disinfected a number of times and mangers scrubbed with banner lye solution.

(44) 1. January, 1897. 2. Seven. 3. None. 4. Ten. 5. One. 6. Chronic diarrhoea. 7. All are doing well except one with tetter. 8 About the same. 9. Not any. 10. I do not know of any. 12. I have made no change as I always kept things in pretty good order.

(45) 1. 1896. 2. Two. 3. One. 4. One. 5. None. 9. One cow.

(46) 1. October, 1896. 2. Fifteen. 3. None. 4. Twelve. 5. One. 6. Calving. 7. Good. 8. No change. 9. None. 10. There is very little heard.

(47) 1. 1897. 2. Five. 3. None. 4. Four. 5. No. 7. All right. 8. About equal.

(48) 1. 1892. 2. Fifty. 3. Three. 4. Sixty. 5. Seven. 6. Milk fever 2, pleurisy 1, bloat 3. 7. Better. 8. Much greater. 9. Nothing. 10. Not very prevalent. 11. An infected animal purchased for the herd. 12. But little.

(49) 1. March, 1897. 2. Seventeen. 3. None. 4. Fifteen. 5. None. 7. Much better. 8. Better. 9. None. 10. Not near as many; people are getting more careful. 11. No. 12. Have given it a general overhauling.

(50) 1. February, 1897. 2. Twenty-three head. 3. None. 4. Sixteen. 5. Two. 6. One of milk fever. One being stopped up in manifold. 7. In better condition. 8. About the same. 9. Lost none. 10. I think there is some among the stock in these parts.

(51) 1. April, 1897. 2. Five. 5. None. 7. Better. 8. About the same. 10. My opinion is that there is some.

(52) 1. December, 1897. 2. Nineteen. 3. Three. 4. Seventeen. 5. None. 7. Good. 8. Not near as good as before; it is a different

lot of cows. 9. About $215. 10. Plenty, if looked after. 11. From a drover who shipped from New Jersey. 12. New stalls and mangers; the inside made new.

(53) In 1893 had to kill three head; they were not tested but were in last stages and killed them to get rid of them. 1. 1896 and 1897. 2. Fourteen. 3. Nine. 4. Thirteen. 5. Not any. 7. In good condition. 8. Improved. 9. Between $400 and $500. 11. Cattle bought from Wm. Singerly, Philadelphia, in 1892. 12. Interior of stable changed; old floors replaced by cement, stable raised, five more windows and doors.

(54) 2. Ten. 3. Three. 4. Seventeen. 5. None. 7. Healthy and fine. 9. $50.

(55) 1. February, 1897. 2. Eighteen. 3. Not any. 4. Fifteen. 5. Not any. 7. Apparently the same. 8. About the same. 10. Most of my herd I raised. I do not know of any affected in the vicinity at present. Think is more prevalent among cattle brought from a distance.

(56) 1. December, 1897. 2. One cow. 3. One. 4. None. 7. Have none. 9. $25. 12. Whitewashed and lined with tar paper.

(57) 1. January, 1897. 2. Two. 3. One. 4. Not any.

(58) 1. November, 1896. 2. Sixteen. 3. Four. 4. Eight above one year and four under one. 5. None by disease. 6. Lost one calf six months old, with every evidence of poisoning by accident or intention; I know not which. 7. In excellent condition generally. 8. I have none of the original cows that I owned at the time of the inspection, all were sold that were in any profit and the balance kept, one bull kept and four heifers; all but one heifer was pastured in a separate field, but occupied the same stable at night, each having an individual stall. 9. $50. To this might be added $100 uselessly wasted in hay and feed to cattle in no condition to pay their way, because of their unthrifty condition, costing me in an indirect manner as above stated. 10. Much less than a year ago. The examination of my herd caused the owners of several such to quietly bury them and pocket the loss. 11. The condition of the worst one bought, indicated the existence of the disease in her at least a year before I owned her, if not longer; this, no doubt, was the direct and only cause of my experience of the disease. 12. A general renovation and disinfection, removal of some of the surface soil of stables. The stables have been cleaned to the bottom at least once a week since and allowed to dry out till new bedding was put in, making them freer of bad odors and dampness, the latter of which is a disease producer, especially where but little sunlight can be had.

I am glad to report favorably and hope the agitation of the subject has helped to eradicate many existing cattle that were diseased; many have been killed quietly by those who were selling milk, be-

cause they did not wish their customers to know that the disease was in their herds. I might say that I think there is more disease among such herds than there is where butter is made, because of heavy feeding, and some times of feed of doubtful utility. Gluten being bad for cows, I think, causing them to cough as long as it is fed, though my herd gained in milk and gave a better analysis under its use; some of the gluten feed purchased, affected the cattle worse than others, so that I have about concluded to use something else.

I shall be glad to receive any reports issued by the Department touching the dairy interests of farmers. I am trying to raise most of my own cows and thus avoid some of the risk in buying drove cows.

The law passed to require the inspection of cattle coming into the State is in line of my suggestions, except that I would suggest a closer inspection of the cars which carry the cows, for I believe their filthy condition often is a producing cause of disease, and their appearance indicates that the same car carries several loads without cleaning or disinfection; this should be remedied.

(59) 1. 1896. 2. Two. 3. One. 4. One. 5. None. 7. Good. 9. About $30. 11. By buying the cow of a cattle dealer; I only had her about six months.

(60) 1. August, 1896. 2. One. 3. One. 4. None. 5. None. 8. $40. 10. Apparently greatly reduced. 11. No.

(61) February, 1897. 2. One. 3. One. 4. None. 5. None. 7. Have not kept a cow since. 10. Those that suspected disease and were tested, generally lost a few. Many that suspect disease often dispose of it sooner than expose the entire herd to test. 11. I bought the cow about eight months before the test for the milk for own use.

(62) 1. January, 1897. 2. Fourteen. 3. Eleven. 4. Eleven. 5. None. 7. Compare very favorably. My cattle seem healthy. 8. I have about same amount. 9. $700. 10. I am of opinion it is prevalent more or less in large herds. 11. I do not. I sold and filled in whenever wanted, as is custom here generally in the fall. 12. I cleaned out the premises and disinfected with carbolic acid and lime.

(63) 1. March, 1897. 2. Eight. 3. Not any. 4. Eighteen. 5. Not any. 7. No. change. 8. No perceptible difference. 10. Do not know of any, although there are a great many cattle brought here from New York State and western Pennsylvania. My herd consists of Jerseys and grades; we expected to find two of them affected but they were not.

(64) 1. January, 1897. 2. Eleven. 3. Three. 4. Ten cows, one bull, seven heifers. 5. None. 7. They are doing very well and looking good. 8. They are doing better than they did before the test, we are making more butter. 9. Over $100. 10. I do not know. 11.

I think I got it with a cow I bought at a sale at Langhorne. 12. We dug the stables out about 4 or 5 inches and refilled with fresh earth, giving them a thorough washing with acids and whitewashing them with lime and carbolic acid.

(65) 1. 1896. 2. Eight. 3. One. 4. Eight. 5. One. 6. Milk fever. 7. About the same. 9. $30. 11. I bought from a dealer.

(66) 19. October, 1896. 2. Six. 3. Six. 4. Seven. 5. None. 7. Have a new lot of cows. 9. $75, and was without cows for some months. 10. Not so prevalent as it was. 11. The only way I can account for it was through a cow I purchased from a neighbor. She would not get with calf. I purchased, fattened and slaughtered her and had to take the whole carcass and bury it; since that time we have had more or less of it among our stock. 12. The floor removed and the stable thoroughly disinfected.

(67) 1. June, 1896. 2. Seven. 3. One. 4. Eight. 5. None. 7. Good. 8. About the same. 9. $74. 10. None here. 11. Bought an Ohio cow.

(68) 1. May, 1896. 2. Fifteen. 3. Fourteen. 4. Nine. 5. One. 6. Pneumonia. 7. Good. 8. I can see no difference. 9. $3,000. 10. I think there are several herds affected. 11. I feel certain that the infection was brought by a cow that I bought six or eight years ago.

(69) 1. June, 1896. 2. Two. 3. None. 4. None. 5. None.

(70) 1. Fall of 1897. 2. Four. 3. Not any. 4. Four. 5. Not any. 7. In healthy condition. 8. I have but one cow that was tested and she is doing fairly well at milking now; she was sick four weeks with catarrh of the stomach, but is well now. 10. Four of my neighbors have lost a cow apiece; two had them killed when they were in the last stage of tuberculosis; one was slaughtered for beef and thrown away; one sold to Easton butcher, slaughtered and condemned.

Farmers act is if they did not want to know when their cattle are affected with tuberculosis, yet when suspected they will work them off.

(71) 1. November, 1896. 2. Thirteen. 3. Ten. 4. Thirteen. 5. Not any. 7. My herd is entirely new and different breed; I think they are all healthy. 8. Before the test I was making butter from Jersey cows and now I am shipping milk from natives principally Holstein and Durhams; 12 of them are now milking from 140 to 150 quarts per day. 9. $280. 10. Not any as far as I know. 11. I do not, but suppose from in-breeding. 12. The stalls have been torn out and rebuilt and a thorough disinfection through all of the stables.

(72) 1. October, 1896. 2. Thirteen. 3. Eight. 4. Thirteen. 5

None. 7. Show no signs of affliction. 8. Same or rather better; better milk and creamery man is not afraid to take it. 10. I do not know of any in my vicinity. 11. I have no reason to which I can attribute it.

(73) 1. February, 1893. 2. Twelve. 3. Eight. 4. Twelve. 5. Two. 6. Tuberculosis in 1896. 7. About the same. 9. $1,475. 10. I seldom hear any complaint. 11. From the purchase of a cow at a farmer's sale in 1892. 12. The entire stable has been torn out and rebuilt after I lost the eight cows and thoroughly disinfected in 1896 when I lost two more.

(74) 1. 1897; a year ago. 2. Three. 3. One. 4. Two. 5. None. 7. Good. 8. Better. 9. $75. 10. I think there is some. 11. Do not.

(75) 1. June, 1897. 2. Seven. 3. Four. 4. Four. 5. None. 7. Have but one of the same herd. 8. Better. 9. $105. $10. I have no knowledge. 11. By buying two cows.

(76) 1. April, 1894. 2. Six. 3. None. 4. Two. 5. Three. 6. Milk fever 1, nail in stomach, 1 killed. 7. Can see no difference. 8. Same. 9. None. 10. I think it less.

(77) 1. August 16, 1896. 2. Twenty-nine. 3. Not any. 4. Thirty-four. 5. Not any. 7. They are in better condition. 8. Ten per cent. better. 10. Growing less.

(78) 1. May, 1897. 2. Thirty. 3. Two. 4. Twenty-two. 5. None. 7. My cows are in better condition and I get better results from them. 8. Fair. 9. $60. 10. I do not think it bad. 11. I have no idea. 12. Whitewashing and good ventilation.

(79) 1. March, 1897. 2. Twenty-four head. 3. Not any. 4. Twenty-seven head. 5. None. 7. The same. 8. The same. 10. No knowledge of any. 12. No change.

(80) 1. Spring of 1897. 2. Twelve. 3. None. 4. Fourteen. 5. One. 6. Injured and had to be killed—in perfect health. 7. Fine. 8. About the same. 10. Do not know of any. 12. Not finding it necessary to make any change, have only been watchful about keeping everything clean and well aired.

(81) 1. April, 1897. 2. Fourteen. 3. None. 4. Nineteen. 5. None. 7. No difference. 8. No difference. 9. None. 10. Not much.

(82) 1. June, 1896. 2. Twenty-two. 3. None. 4. Twenty-five. 5. None. 7. The same. 8. None. 9. Same. 10. I do not think there are any cattle affected in this vicinity.

(83) 1. April, 1897. 2. Thirty-nine. 3. None. 4. Thirty-nine. 5. None. 7. Equally as good. 8. Equally as good. 9. Nothing. 10. Perhaps 4 or 5 per cent.

(84) 1. February, 1897. 2. Twenty-four. 3. Nineteen. 4. Twenty. 5. None. 7. Better. 8. Average about the same. 9. Considerable. 10. No new herds that we have reason to think have it. 11. I do not.

12. All old stalls taken out and whitewashed thoroughly and new stalls made.

(85) 1. March, 1897. 2. Four. 3. None. 4. Five. 5. None. 7. About the same. 8. The same as before. 10. None affected that I know of.

(86) 1. April, 1897. 2. Eleven. 3. None. 4. Eleven. 5. One. 6. Too much ground feed. 7. The same. 8. The same per head. 9. None. 10. I hear of no complaints.

(87) 1. April, 1897. 2. Eighteen. 3. Not any. 4. Fifteen. 5. Not any. 7. Better. 8. The same. 10. Don't think there is any.

(88) 1. March, 1897. 2. Six. 3. None. 4. Six. 5. Not any. 7. Cannot see any difference. 8. About the same. 10. Very few, if any.

(89) 1. April, 1898. 2. Twenty-five. 3. None. 5. None. 7. Same. 8. Same.

(90) 1. August, 1896. 2. Nine. 3. None. 4. Eleven. 5. None.

(91) 1. September, 1896. 2. Eleven, I think. 4. Nine. 7. Good condition. 8. Same. 9. Lost one cow the fall they were tested. 10. I do not think there is any; several herds have been tested and very few condemned.

(92) 1. July, 1896, and January, 1897. 2. About thirty. 3. None. 4. Forty-seven. 5. None. 7. No change. 8. About the same. 9. None. 10. Do not know of any.

(93) 1. August, 1896. 2. Ten. 3. None. 4. Ten. 5. None. 7. About the same. 10. There is said to be some in one herd about 3 miles from here.

(94) 1. April, 1897. 2. Eighteen. 3. Two. 4. Twenty-five. 5. None. 7. Good; look better now. 8. Made no difference; better feed, more milk. 9. $25. 10. Nearly gone; seldom hear of any.

(95) 1. August, 1896. 2. Sixteen. 4. Thirteen. 5. None. 7. About the same. 10. Very scarce.

(96) 1. April, 1898. 2. Nine. 3. None. 4. Nine. 5. None. 7. No physical change. 8. Not milking at time. 10. Very few, if any, affected.

(97) 1. 1897. 2. Twenty-five. 3. None. 4. Thirty-six. 5. None. 7. Much better. 8. No special change. 10. I do not think there is much.

(98) 1. March, 1897. 2. Thirty-two. 3. None. 4. Forty. 5. None. 8. It was never better than the past year. 10. There is very little in this vicinity.

(99) 1. April, 1897. 2. Twelve. 3. None. 4. Twenty-five. 5. None. 7. In better condition.

(100) 1. October, 1896. 2. Six. 3. None. 4. Four cows. 5. One. 6. Calving. 7. Improved. 8. About the same. 9. None. 10. Small.

(101) 1. January, 1897. 2. Eighteen. 3. None. 4. Thirteen. 5.

None. 7. If anything, better. 8. Ten per cent. better. 10. I think there are no cattle affected here.

(102) 1. March, 1897. 2. Two. 3. None. 4. Two. 5. None. 7. The same. 9. The same. 10. Most of the cattle are looking well, that is all I can say.

(103) 1. March, 1897. 2. Six. 3. None. 4. Eleven. 5. None. 7. A great deal better. 8. Better. 10. I do not think there is very much of it.

(104) 1. November, 1896. 2. Eleven. 3. None. 4. Seven besides four calves. 5. None. 7. About the same. 8. About the same. 9. None. 10. Almost all the herds in this vicinity have been tested.

(105) 1. June, 1897. 2. Sixteen. 3. None. 4. Eighteen. 5. None. 7. Are in good health. 8. Is good. 9. None. 10. Most cattle are in good health.

(106) 1. Spring, 1896. 2. Seven. 3. None. 4. Nine. 5. Not any. 7. Good. 10. I do not know of any.

(107) 1. April, 1898. 2 Seventeen. 3. None. (In July, 1896, 30 cattle in this herd were tested and 11 condemned.) 4. Seventeen. 5. None. 7. The same. Good. 8. Since 1886, $600 above amount paid to me by the State. 9. It is now about 1¼ butter per day. 10. There is some but not very much. 11. Cattle purchased from other farms. 12. Two barns have had entire basements rebuilt and cement floors put in. Have also arranged for good light and ventilation.

(108) 1. January, 1897. 2. One hundred and seventy-five. 3. One hundred and fifty-seven. 4. Two hundred. 5. None. 7. Ninety per cent. better. 9. Large. 10. Very nearly extinct. 11. Yes; I think I do. From New York State. 12. Cleaned up.

(109) 1. December, 1897. 2. Five. 3. One. 4. Eight. 5. One. 6. Inflammation of brain. 7. Good. 8. Do not know. 9. $25. 10. I do not think many cattle are affected. 11. No. 12. Barn burned and a new one built.

(110) 1. February, 1897. 2. Twenty-six. 3. None. 4. Twenty-nine. 5. None. 7. About the same. 8. From tested animals about the same. 10. I don't think there is much.

(111) 1. April, 1897. 2. Six. 3. None. 4. Nine. 5. None. 7. The same. 8. The same. 10. Not any. 12. By a new barn with basement stable.

(112) 1. Fall, 1896. 2. Six cows. 3. None. 4. Eight head. 5. None. 7. I think it is better. 8. Comparatively as good.

(113) 1. May, 1897. 2. Nine. 3. None. 4. Fifteen. 5. None. 7. Favorable. 8. Do not notice any difference. 10. Not so extensive as formerly. 12. The stables are kept cleaner, with better light and ventilation.

(114) 1. March, 1897. 2. Eighty-three. 3. Seventy-eight. 4. Eighty-eight. 5. Two. 6. Tuberculosis. 7. They are a good deal

better condition. 8. I think it is much better. 10. I do not think there is much. 11. From cattle from New York State. 12. I disinfected the barn. One barn burned and I rebuilt. I whitewash them frequently.

(115) 1. October, 1896. 2. Nineteen. 3. Fourteen. 4. Ten cows, three yearlings and eight calves. 5. None. 7. Good. 8. Milk production before test about one-half what it should have been—at present time as good as the average dairies. 9. Sixteen animals lost. 10. Very little. 11. No. 12. New interior.

(116) 1. May, 1897. 2. Twenty-six. 3. Two. 4. Twenty-five. 5. None. 7. About the same. 8. Better this year than last. 9. Two. 10. I do not know. 11. Think from a sick cow brought here which died.

(117) 1. April, 1897. 2. Sixty-eight. 3. Two, but they were bought a few days before testing; all my own were free. 5. One. 6. In flammation of womb after calving. 7. They are as fine as silk. 8. I do not think quite as good, but would think it from other causes; we have been bothered greatly with abortion. 9. Two. They are nearly all purchases from neighboring towns. I do not know of a single animal that has been raised in our township. 11. Two cows bought from a drove. 12. Entirely new stables.

(118) 1. Fall, 1896. 2. Eight. 3. Not any. 4. Ten. 5. Not any. 7. The same. 8. The same. 9. Not any. 10. I do not know of any.

(119) 1. October, 1897. 2. Seven. 3. Three. 4. Five. 5. None. 7. I think that it is better than before. 8. They have not all come in yet, but think it is better. 10 I think that most are all right. 11. It came from a diseased cow that we had some time before, that died of the disease. 12. They have been torn out and new put in and whitewashed and well limed.

(120) 1. July, 1896. 2. Five. 3. None. 4. Six. 5. None. 7. No change. 8. Can not tell.

(121) 1. 1896. 2. Nine. 3. None. 4. Ten. 5. None. 7. About the same. 8. About the same.

(122) 1. April, 1897. 2. Eight cows. 3. None. 4. Fifteen from tested stock. 5. None. 7. As good as they were before testing. 8. No different. 9. None. 10. In herds that have been tested there seem to be very few. 12. Good ventilation and light.

(123) 1. First in 1896; second, June, 1897. 2. Five. 3. Two at first, one at second. 4. Three. 5. Three (those condemned by tests). 6. Tuberculosis. 7. Good. 8. Cannot state accurately. 9. Three. 10. Cannot say. 11. Two cases from Laceyville, Pa.; one from Jefferson, N. Y.

(124) 1. Spring, 1897. 2. Twenty. 3. Not any. 4. Sixteen. 5. Not any. 7. Can not see any difference. 8. Those that are milking

about the same. 9. Not any. 10. There is no tuberculosis in our part; in fact, not any on this side of the Susquehanna river.

(125) 1. September, 1896. 2. Ten. 3. None. 4. Ten. 5. None. 7. About the same. 8. No difference. 10. I think there is very little.

(126). 1. February, 1897. 2. Twenty-eight. 3. None. 4. Sixteen. 5. None. 7. Same as before. 8. The same. 9. None. 10. Not so much.

(127) 1. In 1896. 2. Fifteen. 3. None. 4. Seventeen. 5. None. 7. Fully as good. 8. About the same. 9. None. 10. Very little of it, some scattered cases 12. My stables are warm, cemented floors, well ventilated and lighted.

(128) 1. May 7, 1897. 2. Thirteen. 3. None. 4. Nineteen. 5. None. 7. Better, of any difference. 8. About the same. 10. We do not hear much of it.

(129) 1. April, 1897. 2. Fifteen. 3. None. 4. Fourteen. 5. Not any. 7. Good; if not better than before tested. 8. Just as good. 9. None. 10. I do not think there is much tuberculosis in my vicinity. 11. I do not think I ever had tuberculosis in my herd.

(130) 1. In 1897. 2. Thirty. 3. None. 4. Sixteen. 5. None. 7. See no difference. 8. Same. 10. Do not think it very prevalent.

(131) 1. May 5, 1897. 2. Eighteen of my own. 3. None. 4. Seventeen. 5. Not any. 7. I see no difference. 8. Cannot say; do not remember how many we milked at time they were tested. 9. No loss. 10. I hear of no cases. I am the only person in this immediate vicinity who has had his cattle tested.

(132) 1. In 1897. 2. Seven. 3. None. 4. Thirteen. 5. None. 7. Same. 8. Same. 9. None. 10. Small.

(133) 1. March, 1897. 2. Forty-seven. 3. None. 4. Fifty-two. 5. None. 7. Same. 8. Think better. 9. None. 10. A good many herds tested and only four found and they were traced back to the same herd; do not think there are any diseased cattle in this section of country now.

(134) 1. February, 1897. 2. Eight. 3. None. 4. Ten. 5. None. 7. I can not see any change. 8. I see no difference. 10. Most have been tested, few have been condemned.

(135) 1. May, 1897. 2. Eleven. 3. None. 4. Thirteen. 5. None. 7. Good. 8. The same. 9. None. 10. Do not know.

(136) 1. April, 1897. 2. Twenty-three. 3. No. 4. Eighteen. 5. No. 7. A. No. 1. 8. More now. 10. Not much.

(137) 1. November, 1896. 2. Eight. 3. Not any. 4. Seven. 5. Not any. 7. About the same. 8. Just as good, if not better. 9. No loss. 10. Not as large a percentage, but in my opinion a good many yet.

(138) 1. May, 1897. 2. Ten. 3. None. 4. Ten. 5. None. 7. Can

see no difference. 8. No perceptible difference. 10. Don't know of a single case within 15 or 20 miles.

(139) 1. January, 1897. 2. Fifteen. 3. Ten. 4. Twenty-five in all. 5. One yearling and one young calf. 6. Yearling, inflammation of lining of abdomen; little calf, scours. 8. Good. 9. $202. 10. Cannot tell. 11. Think from a cow brought into neighborhood from Philadelphia. 12. The stable was cleaned out, washed and disinfected according to directions; the floors are nearly all made out of cement, stone and gravel. They are washed and disinfected and where there was any plank floor it was taken out and new put in.

(140) 1. January, 1897. 2. Eighteen. 3. Not any. 4. Twenty-four. 5. None. 7. In good condition. 9. None. 10. I think very little exists. Most herds have been tested and found to be comparatively free.

(141) 1. April, 1897. 2. Fifteen. 3. None. 4. Thirteen. 5. One. 6. Milk fever. 7. Good. 8. Just as good. 9. I have never had tuberculosis in my herd. 10. It is not very large.

142) 1. October, 1896. 2. Ten. 3. None. 4. Twelve. 5. One. 6. The covering of the heart was affected. 7. About the same. 8. The same. 9. None directly, but one indirectly. 10. Do not know of any.

(143) 1. In 1896. 2. Five. 3. Two. 4. Two. 5. None. 7. Better. 8. About the same. 9. $25. 10. There is too much of it. 11. No. No.

(144) 1. April, 1897. 2. Four. 3. None. 4. Four. 5. Not any. 7. No change noticed. 8. No change. 10. I do not know of a case in this community.

(145) 1. January, 1897. 2. Nine. 3. None. 4. Twelve. 5. Not any. 7. About the same. 8. About the same. 10. About 5 per cent.

(146) 1. June, 1897. 2. Seven. 3. None. 4. Five. None. 7. About the same. 8. No perceptible difference. 9. None. 10. There has been very little of it in this vicinity.

(147) 1. March, 1897. 2. Seven. 3. None. 5. None. 7. Seem to be fully as hearty and well. 9. Fully as much or more. 9. None. 10. Our creamery has undertaken to test all its cows and out of 560 tested, five have been condemned and killed. Less than one per cent. 12. Have added more stable room and keep cows and calves in separate parts of barn.

(148) 1. 1896. 2. Seventeen. 3. None. 4. Nine. 5. None. 7. About the same. 8. Do not see any difference. 9. No loss. 10. There are few cases, if any.

(149) 1. June, 1896. 2. Thirty-five. 3. None. 4. Thirty-five. 5. None. 7. The same, as near as I can tell. 8. I can see no difference. 9. Nothing. 10. I think there is none.

(150) 1. May, 1897. 2. Fourteen. 3. One. 4. Fifteen. 5. Not any. 7. About the same. 8. I do not notice any difference. 10. Do not think there is any; most of the herds have been tested and none found. 11. I do not think my herd was infected; the one condemned I bought in Towanda a few weeks before. I learned she formerly belonged to Piollet's herd.

(151) 1. 1897. 2. Fourteen; eleven were tested; the others were calves and not tested. 3. None. 4. Fifteen. 5. None. 7. Better. 8. None. 9. None. 10. There isn't any that I know of.

(152) 1. September, 1896. 2. Eighteen. 3. None. 4. Fifteen. 5. None. 7. Good. 8. Good. 9. None. 10. I do not think there is any around here.

(153) 2. Six. 3. Not any. 4. Six. 5. Not any. 7. All well. 8. It did not make any difference with the quantity of milk. 9. Not any. 10. There is some.

(154) 1. March, 1897. 2. Seven. 3. Five. 4. Seven. 5. Not any. 7. Different cattle. 8. Not so good. 9. $325. 10. There ought to be none as all my near neighbors have had their herds tested. 11. My nearest neighbor brought a cow from Rome that dwindled away and died; he lost two or three, and I had one that got poor and coughed. As the two herds pastured together I thought perhaps tuberculosis was the trouble and had them tested. 12. Changed the cows from north to south barn, about 10 rods difference.

(155) 1. December, 1897. 2. Five. 3. None. 4. One. 5. None. 7. Good. 8. The same. 9. None. 10. It is not very bad.

(156) 1. October, 1896. 2. Forty-seven. 3. None. 4. Forty. 5. One. 6. Heart disease. 7. The same. 8. The same. 9. None. 10. I think there is but little.

(157) 1. December, 1896. 2. Nine. 3. None. 4. Fourteen. 5. One yearling. 6. Blackleg. 7. No perceivable difference. 8. No change. 9. None. 10. Very few affected. 11. Not affected. 12. No change.

(158) 1. February, 1897. 2. Fourteen. 3. Six. 4. Balance of herd. 5. None. 7. The same. 8. Do not know. 9. $200. 10. Cannot say. 11. No.

(159) 1. February, 1897. 2. Eight. 3. None. 4. Fifteen. 5. None. 7. They are in a better condition. 8. About the same. 9. None. 12. Plank floor had been changed to cement.

(160) 1. November, 1896. 2. Nine. 3. One. 4. Eight. 5. None. 7. Better state. 8. Better. 10. Decreasing. 11. The cow was purchased from stock farm at Douglassville, which has since been condemned.

(161) 1. October, 1896. 2. Fifteen. 3. One. 4. Thirteen. 5. Not any. 7. Good all but one. 8. Product is good. 9. Loss would be $60. 10. I do not believe there is any. 11. I do not.

(162) 1. April 7, 1897. 2. Eleven. 3. None. 4. Nine. 5. One. 6. Old age. 7. No difference. 8. The same. 9. From 1891 to 1896 destroyed about 25. 10. Know of none. 11. Do not. 12. More ventilation.

(163) 1. Fall, 1896. 2. Six. 3. Three (in two tests). 4. One. 5. None since second test (sold two). 7. All right. 8. Nothing. 9. $150. 10. I cannot say; think there are some would stand testing. 11. By getting other cattle to my herd. 12. Had the stables and yard disinfected.

I had my herd tested in 1896 and one cow was within a few weeks of dropping her calf; she ran a little high and we came to the conclusion that accounted for it, but now I think she had a touch of it then. She did very well until she had her next calf, then she commenced to go back and became ailing and that caused me to have the second test made, so we had to have two killed, which leaves me one. In such cases I think it would be well to test them a few days after dropping their calves. What I have left now is all right. There are several herds around that I think should be tested, as I think my cattle got it from this herd by getting them on the place. We have some people that will not admit it, they do not care how much a poor man must suffer through it. I think each and every herd should be twice a year tested, with or without consent, to get rid of the trouble. I think in this way it could be gotten rid of in a short time. There are some of the people think their cattle have it and dispose of them, then others must suffer the penalty.

(164) 1. January, 1897. 2. Nine. 3. One. 4. Eleven. 5. None. 7. Good. 11. I do not.

(165) 1. October, 1896. 2. Seventy-three. 3. Nineteen. 4. Sixteen. 5. Two. 6. Accident. 7. Same, except as to number. 8. No. material change. 9. $1,200. 10. Have none. The test should be general and compulsory. 11. Have no knowledge. 12. Ventilation, light and cleanliness always faultless.

(166) 1. November, 1896. 2. Nine. 3. One. 4. Nine. 5. None. 7. Better. 8. About the same. 9. $72. 11. By a western cow.

(167) 1. 1896. 2. Seven. 3. One. 4. Six. 5. One. 6. Paralysis. 7. Very good. 8. About the same. 9. One cow. 10. Very few cattle are infected in this neighborhood. 11. Only had one infected and killed; the same was bought of Wm. Singerly in February, 1891.

(168) 1. December, 1897. 2. Nineteen. 3. Three. Have lost 14 cows from tuberculosis in eight years. 4. Seventeen. 5. One. 6. Not able to say, but had her opened, and she did not die with tuberculosis. 7. As far as I can see my herd is healthy at present. 8. About the same to the number of cows I had. 9. $600. 10. Not able to answer. 11. By buying western cows. 12. The gutter and troughs well cleaned and disinfected.

(169) 1. May, 1896. 2. Two. 3. One. 4. Four. 5. None. 7. Some-

what improved. 8. About the same. 9. $50. 10. I have heard of no complaint. 11. I suppose from cattle that passed my place from Virginia.

(170) 1. December, 1897. 2. One. 3. None. 4. Two. 5. None. 7. They are all right now. 8. No difference in the quantity. 9. $51. 10. None. 11. One was coughing when I bought her, the other cow was all right.

(171) 1. October, 1896. 2. Twenty-one. 3. Sixteen. 4. Thirty-four. 5. Not any. 7. I have all new stock and cannot answer. 8. As I have another herd it would be a difficult question to answer. 9. $600.

(172) 1. May, 1896. 2. One. 3. One. 4. One. 5. None. 7. Same. 8. Cow about to calve. 9. $12. 10. Do not think there is much. 11. Mother of cow.

(173) 1. October, 1896. 2. One. 3. None. 4. One. 5. None. 8. About the same. 9. No loss. 10. I know of none. 11. Had none affected.

(174) 1. April, 1897. 2. One. 3. None. 4. One. 5. None. 7. Good. 8. No apparent change. 10. I believe it exists in a moderate form.

(175) 1. January, 1897. 2. Two. 3. None. 4. One cow. 5. None. 8. About the same. 9. Nothing. 10. I have no knowledge.

(176) 1. June, 1896. 2. Fifteen. 3. Ten. 4. Ten. 5. None. 7. would say none of my cows died since the test, but I sold two of them. I also raised four young ones out of the tested cows. As they all appear to me now, and all winter, they look very healthy. 8. It is about the same. 9. $500. 10. Cannot express myself on that point. 11. I do not; I suppose they had it when we got them, as we bought them from Economy. 12. Disinfected.

(177) 1. October, 1896. 2. Three. 3. Two. 4. One. 5. None. 9. The two cows killed, could not state exactly—consists of inconvenience and inability to rent pasture. 10. Opinion not worth much, but think there is but little. 11. No idea.

(178) 1. January, 1897. 2. had ten head of cattle. 3. Three were condemned. 4. At present we have five cows and six calves. 5. We lost none since the test. 6. We butchered three, none of which were affected. 7. Our herd is in good condition now. They were also in fair condition before the test. 8. This year near the holidays the average was about seven pounds of butter a week more than last year. 9. $100. 10. I do not think there is any tuberculosis here at present. 11. We do not know.

(179) 1. December, 1896. 2. Fourteen. 3. Eleven. 4. Eight. 5. One. 6. Tuberculosis. 7. All right. 8. $1,000. 10. It is reduced, but still some here and there. 11. Yes; I got one cow, a Guernsey,

that died tuberculosis. 12. By a thorough scrubbing and whitewashing.

(180) 1. July, 1896, and April, 1897. 2. Nine. 3. One. 4. Nine. 5. (Before second test) one. 6. Pneumonia and tuberculosis. 7. Much better. 8. Considerable more. 9. Value of two cows. 11. No.

(181) In February, 1897. 2. Ten. 3. Two. 4. Seven. 5. None. 7. In far better condition. 8. My cows are all springers and not in profit at this time, but are in a good healthy condition. 9. $20. 10. The disease exists to some extent. 11. Through a neighbor's bull that was afterwards killed for beef and found to be diseased. 12. Putting in new stabling and applying whitewash.

(182) 1. April, 1897. 2. Nine. 3. One. 4. Seven. 5. One. 6. From calving. 7. Good. 8. Cannot say. 9. $25. 10. I believe some. 11. I do not.

(183) 1. January and August, 1897. 2. About 12. 3. Four. 4. Ten. 5. Not any. 7. I see no evidence of tuberculosis. 8. I make butter, consequently the milk is not tested, but I think my herd is doing better. 9. About $75. 10. I believe there is a great deal of it here, but the farmers do not seem inclined to do their part toward eradicating the disease. 11. I bought a cow that was badly affected which came from Maryland. 12. I kept my stock away from the barn September and October, and had the building thoroughly cleaned and whitewashed, also used chloride of lime in profusion. I think the State Department should not only recommend this precaution but demand that it should be done. I believe the use of the products of diseased cows brings more misery upon the human family than any other one cause.

(184) 1. August, 1896. 2. Seven. 3. One. 4. Five. 7. The cows are in healthy condition. 8. Better. 9. One. 10. I do not know of any. 11. The cow had the disease when we bought her.

(185) 1. In November, 1896. 2. Five. 3. Five. 4. None. 5. Not any. 9. $450. 10. Not so bad as it was. 11. Do not. 12. Nothing done to them since.

(186) 1. March, 1896. 2. Ninety-six. 3. None. 4. Ninety-one. 5. Six. 6. Four "milk fever," one "nail found in heart," one calving. 7. Same. 8. No change. 9. Nothing.

(187) 1. 1897. 2. Forty. 3. None. 4. Thirty-five. 5. Not any. 7. About the same; healthy. 8. About the same. 10. I do not know of a single case.

(188) 1. August, 1896. 2. Two. 3. One. 4. Thirty-three head. 5. None. 8. One cow. 9. One cow. 10. I do not know of any. 11. No.

(189) 1. June, 1896. 2. Fourteen. 3. Ten. 4. Seventeen. 5. Not any. 7. I think the cattle are in a healthy condition. 8. Bet-

ter. 10. I think the cattle are in a healthy condition. 10. I do not know of any. 11. I do not.

(190) 1. December, 1896. 2. Twenty-three. 3. None. 4. Twenty-two. 5. Have not lost any. 7. Conditions similar. 8. About the same. 9. One cow valued at $40 in February, 1896. 10. I think there is very little in this vicinity. 11. The cow I killed I purchased from a drove in May, 1895, was doubtless affected when I got her. She was with the herd all summer; about the time they came off pasture in fall she was isolated until she was killed, after which time application was made to have the rest of the herd tested.

(191) 1. October, 1896. 2. Eleven. 3. None. 4. Eleven. 5. None. 7. No noticeable change. 8. About the same. 10. A bad disease; slow but sure; not many diseased here. 12. From pole and chains to stanchions and from ground floor to plank ones.

(192) 1. October, 1896. 2. Eleven. 3. None. 4. Ten. 5. None. 7. All right. 8. About the same. 10. Do not think there is any.

(193) 1. May, 1897. 2. Ten. 3. None. 4. Thirteen. 5. None. 7. The same. 8. The same. 10. I think very little, if any.

(194) 1. July, 1896. 2. Fifteen. 3. Not any. 4. Twenty. 5. Not any. 7. About the same. 8. Not any. 9. About the same. 10. There is none in the neighborhood.

(195) 1. September, 1896. 2. Five cows. 3. None. 4. Twenty-one. 7. About the same as it was before the test. 8. About the same. 9. $100. 10. Do not think there is much. Do not know of any. 11. I killed one steer in 1896 and one bull that were condemned and they were among a lot of cattle bought in Buffalo, N. Y.

(196) 1. August, 1896. 2. Eleven or twelve. 3. One. 4. Ten. 5. Two by tuberculosis. One was a steer bought since the test for beef. 6. Were killed for beef and found diseased and buried. 7. No difference noticeable. 8. Same. 9. $70. 10. I believe on the increase. 11. No; unless I got it from cattle that I bought in Sullivan and Bradford counties to feed for beef.

(197) June, 1896. 2, Fifteen. 3. Not any. 4. Sixteen. 5. Not any. 7. Our herd has always been in good condition. 8. The same. 10. There is but little. 12. Stables cemented and stanchions put in.

(198) 1. September, 1896. 2. Fifteen. 3. None. 4. Fifteen. 5. None. 7. About the same. 8. About the same. 9. None. 10. Have not heard of any.

(199) 1. June, 1896. 2. Twenty-four. 3. Eleven. 4. Twenty-three. 5. None. 7. They are in better condition. 8. They are giving more milk. 9. $475. 10. I do not think there are many affected. 11. I bought one cow and one heifer of Mr. Singerly; the cow died about two years before they were tested and I think she was affected. 12. The old mangers have been removed and replaced by improved swing stanchions, the plank floor has been replaced with cement, the ceil-

ings have been raised, the windows enlarged, the alley between the rows of cows is wider than before.

(200) 1. 1896. 2. Thirty. 3. None. 4. Twelve. 5. None. 8. No difference. 9. Nothing. 10. I do not believe we ever had much or any in our neighborhood. I had a good looking Jersey cow that had a weakness, but never betrayed it, but the test proved her free from tuberculosis.

(201) 1. Fall, 1896. 2. Twenty-five. 3. None. 4. Thirty-five. 5. Three. 6. One cow and two yearlings, the former from meningitis, the latter from concretions in rumen. 7. As good, possibly better, condition. 8. Just as good; if any difference, better than before. 9. None. 10. Do not know of any. 11. Never infected.

(202) 1. August, 1896. 2. Eleven. 3. One. 4. Eleven. 5. None. 7. Good. 8. About the same. 9. $13. 10. Very little in our section. 11. No. 12. Special attention has been given to ventilators and cleanliness. The cow that was condemned was in the first stage of the disease.

(203) 1. June, 1896. 2. Eleven. 3. None. 4. Ten. 5. One. 6. Result of eating some poisonous substance supposed to have been wild cherry. 7. All stock in fine condition; same as before the test. 8. No difference. 9. None. 10. There is little or none. 12. My stock is kept in a good warm stable in stanchions, plank floor with drop in rear and a four foot space between drop and trough and side of stable; it is cleaned two and three times a day, and stock is turned out during the day for from one to four hours, except during severe storms.

(204) 1. August, 1896. 2. Fourteen. 3. None. 4. Fourteen. 5. None. 7. About the same. 8. About the same. 9. About the same. 10. I do not know that there is any.

(204) 1. July, 1896. 2. Eight. 3. None. 4. Nine. 5. Two. 6. Apoplexy. 7. Same. 10. None.

(206) 1. March, 1896. 2. Twenty-five. 3. None. 4. Twenty-five. 5. None. 6. None. 7. Good. 8. None. 9. None. 10. None that I know of.

(207) 1. December, 1896. 2. Eight. 3. None. 4. Seven. 5. None. 8. Better than for a few months before. 9. Nothing. 10. None that I know of. 12. Our barn was burned in the spring of 1896 and it was while we were without a barn that we became afraid that our cattle had tuberculosis, and decided to have them tested.

(208) 1. July 6, 1896. 2. Ten. 3. Four. 4. Fourteen. 7. About the same. 8. About the same. 9. $80. 10. I do not think there is half as much of it. 11. Bought a cow from a dealer that was badly affected. 12. No particular change. Stables filled up, disinfected and cleaner stables throughout.

(209) 1. March, 1897. 2. Eleven. 3. None. 4. Eleven. 5. None.

6. None. 7. Better. 8. Better. 9. Nothing. 10. None that I know.

(210) 1. February, 1897. 2. Twenty. 3. Nine. 4. Nineteen. 5. None. 7. Good. 8. About the same as before. 9. $265. 10. Do not know of any. 11. We bought four head and they had the disease.

(211) 1. January, 1897. 2. Eight. 3. Five. 4. Thirteen. 5. None. 7. Better than before. 8. More and better quality since. 9. $340. 10. I do not think there is any tuberculosis in this vicinity. 11. I do not know how they became infected. 12. Thoroughly disinfected.

(212) 1. February, 1897. 2. Three. 3. One. 4. Three. 5. None. 7. All right. 8. About the same. 9. $50. 10. They certainly look very good. 11. I do not.

(213) 1. June, 1896. 2. Seventeen. 3. One. 4. Seventeen. 5. None. 7. Healthy. 8. Same. 9. $25. 10. Very healthy. 11. By buying a Jersey cow at a sale.

(214) 1. 1897. 2. Eight. 3. None. 4. Twelve. 5. None. 7. About the same. 8. About the same. 9. About the same. 10. There is none that I know of.

(215) 1. February, 1897. 2. Eleven. 3. Seven. 4. Replaced by twenty-two. 5. None. 8. Improved fully 100 per cent. 9. Cannot say definitely. 10. Plenty of it. 11. By buying diseased cattle out of William J. Rose's stable. 12. Thoroughly renovated according to directions of Dr. Oyler. The stable dug out, filled up and new troughs and races.

(216) 1. August, 1897. 2. Thirteen. 3. Not any. 4. Fifteen. 5. Not any. 7. Better. 8. Better. 9. Not any. 10. Not any.

(217) 1. December, 1896. 2. Five. 3. Four. 4. Five. 5. One. 6. Inflammation of the womb. 7. About the same. 8. According to the amount of butter churned not as great. 9. $125. 10. There seems to be none of it prevailing in this vicinity at present. 11. Through contact with diseased cow of a neighbor. 12. To no extent except the full application of the disinfectant measure recommended in your pamphlet; our stables were in first class condition before the test.

(218) 1. June, 1896. 2. Four. 3. Two. 4. Three. 5. None. 7. Apparently all right. 8. About the same. 9. Lost $145 worth of cattle. 10. More than people are aware of. 11. No. 12. Disinfected stable as directed. Used carbolic acid.

(219) 1. June, 1896. 2. Fourteen. 3. Six. 4. Thirteen. 5. Not any. 7. In good condition now. 8. One-third more after test. 9. $225. 10. I do not know. 11. I do not. 12. Disinfected.

(220) 1. March, 1896. 2. Fifteen. 3. Fifteen. 4. Eight. 5. One. 6. Chronic pneumonia. 7. Herd is in fine condition; no signs of disease. 9. $145. 10. Do not know of any cases in this neighborhood. 11. Never could account for it. 12. The barnyard was thoroughly

cleaned and also went over the stable three times with carbolic acid, lime and water, using spray pump, and afterwards whitewashed.

(221) 1. March, 1897. 2. Fifteen. 3. None. 4. Fifteen. 5. One. 6. Bloated. 7. Fully as good. 8. Nothing. 9. Nothing. 10. I know of none.

(222) 1. February, 1897. 2. Twenty. 3. None. 4. Seventeen. 5. None. 7. About the same. 8. No loss. 9. No loss. 10. Only one or two individual cases in several miles. 12. By admitting more light.

(223) 1. January, 1897. 2. Nine. 3. One. 4. Thirteen. 5. None. 7. Better in every respect. 8. Somewhat better. 9. $25. 10. I think the disease is on the decrease. 11. I do not.

(224) 1. January, 1897. 2. Four. 3. None. 4. Seven. 5. None. 7. About the same. 8. Same. 10. It is getting less.

(225) 1. February, 1897. 2. Nineteen. 3. Nine. 4. Fifteen. 5. One. 6. Broke his neck. 7. Very good. 8. Much better. 9. $500. 10. I believe there is some. 11. I think from a bull shipped from the west. 12. Thoroughly cleaned and disinfected.

(226) 1. 1897. 2. Twenty-two. 3. Five. 4. Twelve. 5. One from bloat. 7. They are in good condition. 8. Is good at present. 9. $125. 10. I do not think there is any in our neighborhood at present. 11. I do not.

(227) 1. 1897. 2. Six. 3. Two. 4. Seven. 5. None. 7. Much better. 8. Big increase. 10. Not any to my knowledge. 11. I do not. 12. Thoroughly overhauled.

(228) 1. June, 1897. 2. Four. 3. None. 4. Three cows. 5. None.

(229) 1. January, 1897. 2. Eleven cows and nine steers. 3. Three cows. 4. Nine cows. 5. None. 7. They are in a good condition. 8. I am unable to tell. 10. Not any to my knowledge. 11. I do not know.

(230) 1. May, 1897. 2. Fifty-nine. 3. Five. 4. Fifty-six. 5. None. 7. The general appearance is about the same as the cows condemned were in the best condition and no cough. 8. I see no difference. 9. $200. 10. I think there are more diseased cattle than is generally supposed. 11. By buying two cows from a neighbor. 12. Thoroughly disinfected.

(231) 1. 1896. 2. Three. 3. One. 4. Three. 5. None. 7. Good. 11. Bought of neighbor.

(232) 1. November, 1897. 2. Seven. 3. Seven. 4. Six. 5. Seven. 6. Yellow fever. 7. Good. 11. I got by buying cows at sales from shysters.

(233) 1. October, 1896. 2. Eleven. 3. Four. 4. Eight. 5. None. 7. My herd is doing well. 9. $50. 10. I do not know of any. 11. I do not.

(234) 1. November, 1896. 2. Twenty-one. 3. Two. 4. Sixteen. 5. None. 7. About the same. 8. No difference. 9. Could not tell. 10. Do not know. 11. No, sir.

(235) 1. January, 1897. 2. Twenty-two. 3. Twenty. (The two head of young cattle that were left I also killed, so as to be sure to stamp out disease.) 4. Eight. 8. New herd tested and milk product as good after test as before. 10. Butchers occasionally find one supposed to be affected. 11. Four years before my cattle were killed I bought a cow which I think was infected. Then overcrowding and close confinement. (I practice soiling.) 12. Every stick of timber and boards taken out, except ceiling, and thoroughly disinfected, then left almost three months and filled up with fresh earth before putting new mangers and floor.

(236) 1. February, 1897. 2. Sixty-eight. 3. Forty-six. 4. Sixty-four. 5. One. 6. Dropsy. 7. Apparently the same. 8. About the same proportionately. 9. $2,500. 11. No. 12. Thoroughly cleaned, disinfected and generally renovated.

(237) 1. June, 1896. 2. Ten. 3. Five. 4. Twelve. 5. None. 7. All right. 11. I do not.

(238) 1. April, 1897. 2. Twenty-five. 3. None. 4. Twenty-four. 5. None. 7. No change. 8. About the same. 9. Nothing. 10. About six per cent. infected.

(239) 1. 1896. 2. Eight. 3. None. 4. Eight. 5. None. 7. Good. 9. About the same. 10. Have none. 11. No.

(240) 1. October, 1897. 2. Seven. 3. None. 4. Five. 5. None. 7. All right. 10. I know of no cases. 11. They were not infected with tuberculosis but were sick and veterinarian did not tell me what was wrong.

(241) 1. April, 1897. 2. One cow and one calf. 3. One cow. 4. Ten head. 5. None. 7. Good. 8. Good. 9. $10. 10. There is some that I know of. I do not know. 12. I did not keep cow in the stable with rest.

(242) 1. In 1897. 2. Two. 3. One. 4. One.

(243) 1. April, 1897. 2. Eight. 3. Four. 4. Six. 5. Not any. 7. At present they are perfectly sound. 8. About the same. 9. $60. 10. I know of none in the neighborhood at present. 11. I think from one of the Holstein cows I bought from Dupont Dairy of Wilmington three years since. 12. It has been whitewashed frequently and kept cleaner.

(244) 1. December, 1896. 2. Twenty. 3. Four. 4. Nineteen. 5. None. 7. It is healthy. 9. $60. 10. I believe we have some of the disease, but not more than usual in other sections. 11. Do not know. 12. We have scrubbed and whitewashed and used disinfectants of various kinds.

(245) 1. January, 1897. 2. Sixty-three. 3. Fifty-two. 4. Twenty-eight. 5. None. 7. Good. 8. Milk is not as rich. A herd of good cows of years of raising and buying is not to be picked up in one year. 9. $2,500 would not cover loss. Cows in that herd cost us $70. Money cannot replace the loss. As to disadvantages, we lose manure, years of hard work and milk trade. 10. I think it is being wiped out. The test is doing its work well for the community. 11. High feeding, taking out their strength in good milk year in and out. 12. Stables dug out a foot deep, filled in with fresh sand, fresh dirt, stalls thoroughly disinfected, whitewashed, plenty of fresh lime. Stables rested from cows few months, fresh air, sunlight, plenty carbolic acid used in whitewash and chloride of lime. We believe in the test and that it should be a law of Pennsylvania.

(246) 1. March, 1897. 2. Five. 3. Four. 4. Five. 5. None. 7. Perfect as far as we know. 8. Cannot make a satisfactory comparison as we try to have our cows come in fresh during April and May. Just now (April 11), we are only milking one cow. 9. $150. 10. Do not know of any, but think its presence is revealed by test. 11. We remember some years ago we had a cow die that was probably affected with tuberculosis. At that time we were not so well informed and thought nothing of the symptoms. 12. After the test in March, 1897, we removed the cows from the part of the stable they had been using and did not put them back there until October following. The stalls were washed with a carbolic solution after the test.

(247) 1. 1897. 2. Three. 3. Two. 4. Three. 5. None. 7. I consider good. 9. The value of two cows. 10. Do not know of any. 11. No.

(248) 1. June, 1897. 2. One. 3. None. 4. One. 5. One. 6. Do not know. 10. Don't hear of any.

(249) 1. October, 1896. 2. Six. 3. One. 4. Fourteen. 7. A new herd. 9. $75. I disposed of cattle as soon as I found only one was affected. 10. Don't know of any. 11. Do not.

(250) 1. 1897. 2. Thirty-four. 3. Three or four. 4. Twenty-eight. 5. None. 7. My herd is now in fine condition. 8. See no difference, according to number of cows. 9. About $150. 10. Don't think there is very much. 11. I do not, but believe from a standard Jersey bull I bought; I owned him only six or seven months and his case was the worst. 12. Some of my sewers were closed which I had cleaned out and barn cleaned, limed, etc., the best I could get done.

(251) 1. 1897. 2. Thirty-two. 3. Thirty. 4. Twenty-seven. 5. None. 8. It is pretty much the same. 9. $3,500. 10. I think there is a good bit of it. There are plenty of herds would not stand the test. 11. I do not. 12. It was disinfected thoroughly with boiling water, carbolic acid and copperas; then whitewashed.

(252) 1. February, 1897. 2. Fourteen. 3. Twelve. 4. Twenty-nine. 5. None. 7. Have but one cow; bought the stock cattle in Chicago, February 14, 1898, young steers. 8. About the same. 9. $525. The loss of having no cattle for one year. 10. I do not know of any at present. 11. Do not know; had the same herd without any additions by purchase for five years; the nearest infected herd was three miles away. 12. Our farm buildings, except the house were burned last November. Have rebuilt them.

(253) 1. May, 1897. 2. Two. 3. One. 4. One. 5. None. 7. Healthy. 8. I haven't any of the same herd. 9. The value of one cow. 10. Not any that I know of. 11. By a cow bought at a sale.

(254) 1. May, 1897. 2. Three. 3. One. 4. Three. 5. None. 7. All healthy. 8. The remaining about normal. 10. Very little. 11. I do not.

(255) 1. October, 1896. 2. Eight. 3. None. 4. None. 5. None. 10. Very little, if any.

(256) 1. September, 1896. 2. Three. 3. None. 4. One. 5. One. 6. Calving. 8. The same. 9. None. I look upon the question of necessitating tests for tuberculosis as one of the most important before our State government.

(257) 1. Spring, 1897. 2. Nine. 3. One. 4. Nine. 5. None. 7. Very good. 8. Cannot tell; have not kept a record. 9. Two head; one having died just previous to test, and one condemned, $65. 10. It still prevails more or less. 11. By buying from an infected herd without knowldege.

(258) 1. May, 1897. 2. Two. 3. Two. 4. One. 5. None. 7. Cow has remained in fine condition. 8. Much better. 9. $120. Loss of a decent yield of milk for a period of seven years. Loss of eight or ten calves. 10. I do not think it has spread much. There are three or four isolated cases that have come to my knowledge. 11. By buying cow from a drove brought from the mountain of Fulton county. (Perhaps the cow alleged to have been from Fulton county was from some other place; there is little tuberculosis in that section.—L. P.) 12. In my opinion the loss from tuberculosis is incalculable. High feeding, doctoring, unusual care, efforts to build up your herd, all ending in failure, require to be taken into account.

(259) 1. First test July 26, 1896. Second test March, 1897. 2. Twenty-five. 3. Three at first test; none at second. 4. Twenty-six. 5. None. 7. Perfectly sound. 9. Good. 10. I hear or see none prevailing. 11. By a Jersey heifer coming from the eastern part of this State.

(260) 1. 1896. 3. None. 4. Thirty-four. 5. None. 7. Better; new barn, more light. 8. Milking ten cows, getting forty gallons per day. 9. None. 10. None. 12. New barn and light, ventilated stable.

(261) 1. December, 1896. 2. Eight. My cows had a cough at that time, but I think it was caused by rag weed. 3. None. 4. Thirteen. 5. None. 7. Better. 8. Better. 9. No loss. 10. None at the present time.

(262) 1. October, 1896. 2. Six. 3. One. 4. Six. 5. None. 7. Improved. 8. Same. 9. $60. 10. Not any in the vicinity.

(263) 1. October, 1896. 2. Two. 3. None. 4. Three. 5. None. 7. Better. 8. About the same. 10. None that we know of, but we are the only ones who have had a test made in this section. 12. New barn.

(264) 1. Fall, 1896. 2. Four. 4. Four cows. 5. None. 7. My cows are sound. 8. Very good. 9. $80. 10. I think very little. 11. I do not.

(265) 1. April, 1897. 2. Three. 3. None. 4. Seven. 5. One. 6. Hogs killed. 7. Good. 10. None that I know of. 12. Barn moved and fixed over.

(266) 1. April, 1897. 2. Four. 3. One. 4. Five. 5. None. 7. About the same. 8. Yield about the same. 9. $40. 10. Do not know of any cases in this vicinity. 11. I do not.

(267) 1. August, 1896. 2. Three. 3. Two, and one died before the test. 4. Three. 5. None. 7. So far as I know there are none affected. 8. I cannot tell. 9. $230. 10. None of any account. 11. Do not know.

(268) 1. May, 1896. 2. Fifteen cows, five head young cattle. 3. Three cows, three young cattle. 4. Twenty-three head. 5. One. 6. Choked by an apple. 7. Are better than before. 10. Four per cent. 11. I do not know.

(269) 1. June, 1896. 2. Two. 3. One. 4. Three. 5. None. 6. None died. 7. Perfectly healthy now. 8. About the same. 9. One cow June, 1896; value of cow, $41.50. 10. I do not know of any. 11. I do not.

(270) 1. June, 1896. 2. Fifteen. 3. 4. Seventeen; all tested. 5. None. 7. Better condition. 8. Increased in quality and quantity. 10. I think there is some in our vicinity. 12. More windows and ventilation.

(271) 1. January, 1897. 2. Twelve. 3. One. 4. Thirteen. 5. Not any. 7. Herd in good condition. 8. Milk product is better than before the test. 10. I do not know of any around here. 11. I do not.

(272) 1. August, 1896. 2. Eight. 3. Seven. 4. Six. 5. None. 7. Good. 8. Better after test. 9. None since test. 11. No.

(273) 1. Two years ago. 2. Thirty. 3. Fifteen. 4. Twenty-five. 5. None. 7. Improved. 8. No difference. 10. Twenty-five per cent. 11. By the purchase of a cow which died from the effects.

(274) 1. April, 1897. 2. Three. 3. Two. 4. One. 5. None. 7. In good health now. 8. Is much better than before. 9. $60. 11. I do

not know, more than that they started with a cough. 12. I am not living at the same place now. I regard the work of your Board as the best measure for the relief of the farmer from this scourge.

(275) 1. December, 1896. 2. Sixteen. 3. Two. 4. Nineteen. 5. None. 7. Same. 8. Same. 9. Same. 10. Am suspicious of a neighbor's herd. 11. No.

(276) 1. Fall, 1896. 2. Eleven. 3. One. 4. Twelve. 5. Not any. 7. Before test several had a cough, but since all have milked well and seem healthy. Think the cough was caused by dry, dusty pasture. 8. Never milked better than through winter and spring after test. 9. One cow. 11. No; the condemned cow was one we raised on the farm.

(277) 1. April, 1896. 2. Four. 3. Four. 4. Three. 5. None. 7. Have had these three tested and are sound. 8. None tested that were not killed. 9. I would have refused $500 for what I lost with what was tested, as some of the tested cows I refused $75 apiece for. 10. I believe you would find a good bit of it. 11. Through getting animals from an unsound herd. 12. The stables have all been thoroughly cleaned and dug up and whitewashed with carbolic acid in lime. I am a strong believer in tuberculosis; from experience could tell you more than I can write, as I have a little girl with a case of tuberculosis in the hip now; she is only six years old.

(278) 1. August, 1895. 2. Twenty-two. 3. Eight. 4. Nineteen. 5. One. 6. Do not know. 7. Much better physically. 8. Greater in proportion. 9. $260. 10. I think it is much less. 11. Think it came from three cows purchased; two from other states and one from this.

(279) 1. 1897. 2. Twelve. 3. One. 4. Twelve. 5. None. 7. About the same. 8. No difference. 10. Most of the cattle in this vicinity have been tested and the diseased ones killed, so there is very little, if any, tuberculosis about here. 11. My herd was not infected. I bought the cow that was infected. I raised all the others and they were all sound and look fine. 12. Have made no changes. I have tried for years to keep the stables as clean as possible and give the stock pure water and feed, and have no trouble.

(280) 1. 1897. 2. Twenty-two. 3. None. 4. Thirty-five. 5. None. 7. Extra good. 8. Cattle were not affected by it. 9. None. 10. I have no knowledge of any. Cattle seem exceptionally healthy.

(281) 1. December, 1896. 2. Fifteen. 3. Four. 4. Twenty. 5. None. 7. In better condition. 8. Considerably improved. 10. Do not know much about it. 11. Think it was caused by coming in contact with deseased cattle.

(282) 1. February, 1896. 2. Thirty-six. 3. Thirteen. 4. Thirty-seven. 5. One. 6. Leg broken. 7. Much better. 8. The cows that were tested yield better than before. 9. $1,800. 10. Do not know of

any in our neighborhood. 11. Do not know positively. Suppose we bought it. 12. Thoroughly disinfected; wooden manure pits taken out and concrete ones put in; paying much attention to ventilation as we can.

(283) 1. 1896. 2. Three. 3. One. 4. Five. 5. Not any. 7. It is in good condition at present. 8. It is better but we changed cows. 10. I do not know of any diseased. 11. No.

(284) 1. April, 1896, and November, 1896. 2. Twelve. 3. One. 4. Fifteen. 5. One. 6. The veterinarian said the lungs were very much marbled like contagious pneumonia. (Probably sporadic pneumonia.) 7. Don't notice any difference. 8. Average about the same. 9. Two cows lost before the test was made. 10. Don't know of any. 11. Both were infected when purchased. 12. Remodeled and location changed.

(285) 1. 1896. 2. Five. 3. None. 4. Two. 5. None. 7. Improved. 10. There is none in the vicinity.

(286) 1. Fall, 1896, and winter of 1897. 2. Eight each time. 3. First time two, second one. 4. Six. 5. Killed one for beef was all right. 7. They appear better. 8. Per cow I do not think there is much difference, if any it is greater now. 9. This is hard to state but at least $20 per head ($60), besides the loss of the milk and butter. 10. I believe there are a great many infected herds.

(287) 1. January, 1897. 2. Twenty-six. 3. Twelve. 4. One. 5. None. 6. None. 7. I have quit farming and keep but one cow and she seems all right. 8. I am unable to answer, as I kept no record. 9. I could not have replaced the cow for $100 more than I received. 10. Large per cent. of it is affected. 11. I do not.

(288) 1. Fall, 1896. 2. Two. 3. None. 4. None. 5. One. 6. Milk fever. 9. None. 10. Good as far as I know.

(289) 1. October, 1896. 2. Five. 3. One. 4. Six. 5. None. 8. The same. 9. $20. 11. By buying the animal that was condemned.

(290) 1. 1897. 2. Five. 3. One was only slightly affected. 4. Five. 5. None. 7. No difference that I can see. 8. No perceptible difference. 10. Have made no observations. 11. No.

(291) 1. 1897. 2. Ten. 3. Three. 4. Nine. 5. One. 6. Bloated at night; found dead in morning. 7. Much better. 8. Somewhat better. 9. $45 in price of cattle alone. 10. I believe the country is full of it. 11. From a cow I bought at a dealer's sale.

(292) 1. May, 1896. 2. Four. 3. One. 4. Four. 5. None. 7. Better. 8. Better. 9. Four cows. In the spring of 1894 I had a sale of stock; five of the cows were condemned in 1895 and 1896. 10. I think half of the herds in my vicinity have been tested. I believe .05 per cent. would be about right. 11. No.

(293) 1. March. 2. One. 3. One. 4. One. 5. None. 11. I owned the cow only one week before I had her examined.

(294) 1. January, 1897. 2. Fourteen. 3. None. 4. Six. 5. None. 7. Better. 8. Better.

(295) 1. January, 1898. 2. Twelve. 3. None. 4. Twelve. 5. None. 8. I make more butter at present than before the test. 7. If any difference in condition, I think better. 9. In 1896 I had my cattle tested the first time and had two head condemned. One cost $21.50, the other $35. I received for the first $8 and the other $20, a loss to me of $28.50. 10. I think it is getting less. 11. In 1896 my herd became affected by introducing cattle shipped from another State. 12. I changed location since 1896 but we have made no changes since the last test, January 9, 1898.

(296) 1. November, 1896. 2. Ten. 3. None. 4. Fourteen. 5. None. 7. Better. 8. Improved. 10. It is decreasing. 12. No change.

(297) 1. 1896. 2. One. 3. None. 4. One. 5. None. 6. Not any. 7. Same. All the same. 9. Nothing. 10. Nothing that I know. 11. Nothing at all.

(298) 1. April, 1896. 2. Two. 3. One. 4. One. 5. One. 6. Condemned and slaughtered. 7. Sound. 8. Same. 9. Only keep one to two cows for our own family supply. The one condemned is the only loss. 10. Probably 20 per cent. were infected before your Board intervened. Less than 3 per cent. now. 11. The condemned animal was probaly infected when bought from a herd in same county, probably ten months before disease was detected. 12. Cleaning, removal of manure, etc., use of sulphate of iron, chloride of lime, whitewash; and providing additional ventilation and sunlight for stables; all under direction of your deputy.

(299) 1. December, 1896. 2. Four. 3. None. 4. Three. 5. None. 7. About the same. 8. About the same. 9. None. 10. There may be some cases, none, however, that are suspected of having that disease. 2. Eleven. 3. None. 4. Eleven. 5. None. (300). 1. July, 1896. 7. I cannot see any change. 8. The same. 10. I know of none.

(301) 1. August, 1896. 2. Nine. 3. Seven. 4. Thirteen. 5. Not any. 7. My herd is all right. 9. Fourteen cows. 10. I think it is much less than two years ago. Farmers are giving their stock more attention and are not so much opposed to having them examined. 11. Probably brought to my barn by a bull. 12. Everything thoroughly disinfected; no cattle allowed on the ground for the space of about four months; all cattle tested and no symptoms of disease now.

(302) 1. May, 1896. 2. Five. 3. Four. 4. Six. 5. None. 7. Good. 8. Have none of former herd left. Good. 9. $300. 10. There are no doubt some affected but not to a great extent. 11. By the purchase of infected cow. 12. Premises have been thoroughly cleaned and disinfected with carbolic acid and lime.

(303) 1. 1897. 2. Four. 3. Two. 4. Sixteen. 5. None. 7. My

herd is doing well. 8. They milked finely last year. 10. I do not think it was infected.

(304) 1. November, 1896. 2. Nine. 3. Not any. 4. Six. 5. Not any. 6. I sold the fresh cows last fall. 7. About the same. 8. No change. 10. I think there is none in this vicinity. 11. There was a cow running with mine supposed to have it, but it did not prove contagious.

(305) 1. December, 1898. 2. Two. 3. One. 4. Three. 5. Not any. 7. They are fat and sleek. 8. They produce a great deal more. 11. I do not know.

(306) 1. October, 1896; August 17, 1897. 2. The first test 23; second 30. 3. Two. 4. One hundred and seventy-six cows, two bulls, three heifers. 5. One cow. 6. Heart trouble. 7. Herd has been improved. Apperently all healthy. All cows are tested before adding to herd. 8. No effect. 9. Two cows condemned and killed. $45 loss above State remuneration. 10. Do not know that it exists. 11. Were purchased two months and six weeks respectively before they were condemned. Presumably had tuberculosis at the time. 12. A new, well ventilated, lighted and drained barn had just been constructed.

(307) 1. June, 1896. 2. Two. 3. None. 4. Six. 5. None. 7. Condition fine at the time of test, only one had a cough, but thought it better to test both. 10. I do not know of any cases.

(308) 1. June, 1896. 2. Think fifteen. 4. Fourteen. 5. One. 6. Milk fever. 7. Much better. 8. I think a slight increase after the test and diseased animals killed. 9. One. 10. Do not think as many. 11. The herd I raised on the farm when tested were all right and the cows I bought all showed tuberculosis except one.

(309) 1. October, 1896. 2. Nine. 3. Not any. 4. Seven. 5. Killed one. 7. They look splendidly. 8. It is better. 10. I know of none now. 12. In the fall of 1896 my herd looked very badly, one in particular, and several of them coughed. I sent for an inspector and he thought their condition justified a test, which he made; all but one showed no reaction, and she shows no sysptoms at present. My nearest neighbor's herd were all affected the winter previous and he had to get rid of them.

(310) 1. September, 1896, first test; second test January, 1898; the first time I lost ten, the second, four. 4. Five. 5. None. 7. All right. 8. About the same. 10. I think there are some herds that ought to be tested. 11. I bought three cows from Wm. Singerly's sale; they were the first to get sick.

(311) Summer, 1896. 2. Six cows. 3. One. 4. Five. 5. None. 7. Considerably improved. 8. It is better. 9. $18. 10. I think it is very prevalent in some places. 11. I bought the cow out of a drove.

(312) 1. Spring, 1896. 2. Eight. 3. One. 4. Seven. 5. None. 8.

As I have few of the original cows, I cannot say. 9. $20. 10. Do not believe there are many. 11. No; the one condemned was one I raised; the mother was healthy.

(313) 1. June, 1896. 2. Eighteen. 3. Seventeen. 4. Thirteen. 5. None. 7. Satisfactory. 8. More milk now; but on account of breed not the quality. 9. On account of some insurance, the loss on cows did not exceed $100 and the indirect $150. 10. Could form no definite opinion. 11. There is evidence that it was contracted from an animal purchased for breeding purposes. 12. Troughs replaced by new; floors and gutters laid in brick on edge and cemented over. Improvement made in the amount of light admitted by increase in number of windows.

(314) 1. Spring, 1897. 2. Six. 3. None. 4. Six. 5. One. 6. Old age. 7. Good condition. 8. No change. 9. None. 10. Know of none.

(315) 1. December, 1897. 2. Four. 3. Not any. 4. Four. 5. Not any. 7. Same. 9. Same. 10. Not any. 12. Cement floors and underdrained. Barn generally improved. Water introduced throughout for flushing purposes.

(316) 1. June, 1896. 2. Ten. 3. Six. 4. Nine. 5. None. 7. Better. 8. Improved. 9. $220. 10. Not many. 11. No.

(317) 1. Summer, 1896. 2. Four. 3. None. 4. Four cows, two calves. 5. None. 7. The same. 8. The same. 9. None. 10. Do not know of any cases. 11. Have not had it.

(318) 1. 196. 2. Thirteen. 3. Six. 4. Sixteen. 5. None. 7. Healthier. 8. It is about the same. 9. $293. 10. I am in favor of examining cows before admitting into State of Pennsylvania. 11. I suppose from buying other cows.

(319) 1. March, 1897. 2. Two. 3. Two. 4. None. 5. None. 6. We do not keep cows at the present time. 9. $70. 11. Do not know.

(320) 1. December, 1896. 2. Three. 3. Two. 4. Three. 5. None. 7. Are now in first class condition. 8. Small increase. 9. Two. 10. From the number found affected I should think there is considerable more in herds not examined. 11. Think it came from a cow I bought which was raised on an adjoining farm.

(321) 1. January, 1897. 2. Fifteen cows. 3. One. 4. Fourteen cows, two bulls and five heifers. 5. None. 7. I think my cows are all in good health. 8. Better and I know there is no bad milk from my cows. Four and three-fourths to five pounds of butter fat to 100 to milk. 10. I think and know that there are herds that ought to be tested. I would not own a cow that was diseased. 11. I bought the diseased cow you killed. 12. My barn is clean and in good condition and I keep the stalls well whitewashed and well aired and lighted; the young heifers I raised from my own stock. I will not buy a cow that has not been examined.

(322) 1. March, 1897. 2. One. 3. One. 4. None. 5. None. 9. $25. 11. I do not know.

(323) 1. October, 1896. 2. Ten. 3. One. 4. Ten. 5. One; my stock was tested again in March, 1897. 6. Tuberculosis; condemned on second test. 7. In better condition. 8. Better. 9. $35. 10. By being careful what and when buying and by buying expressly of those shipped cattle. 11. By getting cows shipped from the west. Both of them were of that kind.

(324) 1. July, 1896. 2. Eight. 3. None. 4. Seven. 5. None.

(325) 1. July, 1896. 2. Nine. 3. Eight. 4. Seven. 5. One. 6. Died suddenly from indigestion. 7. Have natives now; former herd were Jersey. 9. I received from the State $215 which I suppose was not much more than half of their value. It is hard to tell indirect loss, but I had to buy butter for my custom for several months. The herd was one that contained several superior animals that I have not been able to replace. 10. Do not think there is a great deal for this neighborhood. 11. Five or six years ago I bought a cow in the neighborhood for beef; she was to all appearances healthy, ate well and fattened quickly; kept her for two or three months and killed her and found inside a mass of tubercles. She was buried. 12. Thoroughly disinfected with carbolic acid, tore up the gutter, put them in the stalls with fresh clay and whitewashed stables. Ventilation is good and the cattle are out in a sheltered yard every fair day.

(326) 1. June, 1896. 2. Four. 3. None. 4. Three. 5. None. 7. All right. 8. Same. 10. Do not know of any. 12. Same. The reason I had the herd tested was that one had a cough. After failing to react, the cow was killed and a piece of wire found in her throat, which had produced cough. She was all right otherwise.

(327) 1. 1897. 2. Ten or twelve. 3. Not any. 4. Eleven. 5. Not any. 7. Very best. 8. The very best. I ship to Philadelphia.

(328) 1. April, 1896. 2. Nine. 3. Three. 4. Seven. 5. None. 7. O. K. to the best of my knowledge. 9. I lost two before test and five on test. 10. Do not know of any. 11. I think it came from a young Jersey I raised.

(329) 1. 1897. 2. Think nine. 3. None. 4. Ten. 5. None. 7. Much improved. 8. Milk better since tested. 9. None. 10. Very little.

(330) 1. January, 1897. 2. Eleven. 3. None. 4. Seven. 5. None. 7. Favorable. 8. Favorable. 9. About $500. 10. Prevalent to a limited extent. 11. I apprehend from contact with new or strange cattle.

(331) April, 1897. 2. Seven. 3. One bull. 4. Eight. 5. One. 6. Cancer of the eye. 7. In better condition. 8. About the same. 12. All torn out and dirt taken out and cemented all through.

(332) 1. January, 1897. 2. Five cows. 3. Three. 4. Four cows

and three heifers. 5. None. 6. Not any. 7. All right as far as I know. 8. Not as good, as I lost my best cows. 9. $135. 10. I believe it still exists. 11. From a cow I purchased at public sale. 12. Gave the stable a thorough cleaning, took out about three inches of dirt, whitewashed all the stables and used carbolic acid freely.

(333) 1. January, 1897. 2. Five. 3. Three. 4. Five. 5. None. 6. Not any. 7. Cattle healthy and in good condition. 8. Cows close to calving at time of testing. 9. $100. 10. I think it still exists in many herds. 11. From a cow purchased of a drover at public sale.

(334) 1. July, 1896. 2. Seventeen. 3. Thirteen. 4. None. Disposed by public sale of sixteen head on March 23, 1898. 7. Cattle were apparently healthy. 8. Last herd were ordinary cattle and did not yield as well. 9. From $225 to $250 in excess of sum received from the State. 10. Can form no estimate. 11. No.

(335) 1. Summer of 1896. 2. Six. 3. None. 4. Eight. 5. One. 6. Not of tuberculosis. I think inflammation of the bowels. 7. I parted with the last of those tested about two months ago; they were in as good condition as before the test or better. 8. We are in the habit of weighing the milk of each cow as it is drawn. We noticed difference after the test. 10. I think if tests were made a number of tubercular cattle could be found. 11. About eight months before the herd was tested I had one cow condemned by Dr. E. M. Michener as being tubercular. I bought the cow at a public sale a short time previous and suppose she was infected when I purchased her.

(336) 1. April, 1895. 2. Eleven. 3. Ten. 4. Seven. 5. None. 7. The one remaining cow I had, sold immediately, she having been fattened. 9. $249. 10. As to that I cannot tell. 11. Ten years ago I had a cow which I now suppose had been affected; I have a farm of forty acres that I have been living on for the past thirty years, and was having from twelve to fifteen cows, and was very fortunate for many years with my cattle, not any having died. About ten years ago one of my cows did not seem to be such a good eater, or rather strong feeding did not agree; she picked up and I sold her to a wholesale butcher. (This certain cow had occasionally a discharge from her nose, but I did not think of anything serious.) The cow had been killed and one or two days after I stopped at the butcher's and the man in charge showed me the head and neck of this cow. Well, I acknowledge that it was very pleasing to look at, he telling me it had been that way all down her throat. Some time after I purchased another and placed her in that stall, she being extraordinary good; I raised two heifers; I had the mother cow about five years and she died, and the oldest of the heifers died about one year later, and some time after a fine young Alderney died. My loss of those cows was $114. My suspicions were then aroused and I

decided to have my herd examined and they were all condemned but one, being the other heifer. The exact value of those cows was $449, and $10 for having them examined. The State paid $200. 12. Thoroughly disinfected. Did not stable cattle for six months.

(338) 1. Summer, 1896. 2. Two. 3. None. 4. Five. 5. None. 7. Better. 8. Better. 10. Less.

(339) 1. October, 1896. 2. Twelve. 3. One cow. 4. Eight. 5. None. 6. Tuberculosis. 7. They are well. 8. About the same. 9. $50. 10. Do not know. 11. Was infected from western herd bought September 4, 1896.

(340) 1. January, 1897. 2. Fourteen. 3. Six cows and calf. 4. Eleven. 5. One. 6. Milk fever. 7. Good. 8. Before test four pounds butter to 100; after test four pounds to 100. 9. $280. 10. I think it is pretty well exterminated. 11. Western stock.

(341) 1. April, 1897. 2. Twenty-five. 3. None. 4. Thirty-seven. 5. None. 7. Excellent health. 8. No difference. 10. Less prevalent. 12. More sunlight has been let into the stables; cows have exercise every day.

(342) 1. February, 1897, and July 1897. 2. Twenty cows, 1 bull, 13 heifers. 3. February, 3, July, 2. 4. Twenty-one cows, one bull, twenty-one calves. 5. None. 7. They appear very healthy. 8. About the same. 9. My loss in excess of appraisement is $112. 11. Some of those condemned were from New Jersey.

(343) 1. January, 1898. 2. Sixteen. 3. One. 4. Fifteen. 7. Herd healthy. Milk is better. 9. $115. 10. I do not know of any cattle in my neighborhood that are diseased. 11. By buying cows out of a drove.

(344) 1. October, 1897. 2. Nineteen. 3. Six. 4. Thirteen. 5. None. 7. In a very healthy condition. 8. More satisfactory. 9. $200. 10. I think there is plenty of it in my vicinity. 11. I think my herd contracted it in the stable; it is one of Mr. Wm. Singerly's stables.

All cattle that are shipped from one part of the State to another should be tested before shipping. I have purchased cows from the western part of the State in apparently good condition and nine months later they were dead from tuberculosis.

(345) 1. 1895. 2. Twenty. 3. Two. 4. Twenty. 5. One. 6. Milk fever. 7. Have changed nearly all I had at the time of test. 8. No difference. 10. There are plenty affected with it in the township. 11. Purchased a cow that I sold to the butcher, which proved tubercular.

(346) 1. Fall, 1896. 2. Ten head. 3. One. 4. Seven. 5. None. 7. Appear all right. 8. Better than it was before the test. 9. $500.

10. I know of none. It has prevailed in this locality; some 20 or more animals were slaughtered. 11. By buying a bull at Norristown State Hospital.

(347) 1. Spring, 1897. 2. Fourteen. 3. None. 4. Nine. 5. One. 6. Parturient apoplexy. 7. Doing well. 8. As good as before. 9. None. 10. Know of none. 11. Not infected.

(348) 1. Winter, 1896. 2. Five. 3. Five. 4. None. 5. Not any. 11. Do not know.

(349) 1. April, 1897. 2. Four. 3. Not any. 4. Three. 5. None. 7. Same as before test. 8. Same. 9. $180. 10. Not very prevalent. 11. No.

(350) 1. 1896. 2. Sixteen. 3. Eleven. 4. None. 5. None. 6. Tuberculosis. 8. Not much change. 9. About $200. 10. I think there is a great deal of tuberculosis in this vicinity and every herd should be tested all over the country and the disease exterminated in this way. 11. I think from purchasing three cows from Wm. M. Singerly's herd and raising stock from same. 12. Barn was burnt and I have built a new one.

(351) 1. November, 1896. 2. Six. 3. None. 4. Six. 5. None. 7. I have two of the original herd and they are in good condition. 8. The two heifers tested were not old enough for milk. Since the test they have calved and are better than the average. 10. There have been cases near me. 11. I could not trace the disease. The State Board has done a great work for the farmer.

(352) 1. May, 1896. 2. Fifteen. 3. One. 4. Seventeen. 5. Not any. 8. A great deal better than it has been. 9. A Holstein heifer killed; $22 lost on it. 11. A western heifer.

(353) 1. July, 1896. 2. Eight. 3. One. 4. Eleven. 5. None. 7. They look well. 8. About the same. 9. $25. 10. I think it has less now than it has been, so many herds have been tested. 11. The cow condemned must have contracted the disease before I bought her, she being the only one affected. I owned her only two months before test.

(354) 1. 1896, September. 2. Nine. 3. One. 4. Eight. 5. None. 7. No material change. 9. Sixty dollars. 10. I believe there are still some. 11. I do not.

(355) 1. July, 1896. 2. Twelve. 3. One. 4. Sixteen. 5. None. 7. Better. 8. Greater. 9. None. 10. Limited. 11. By introducing a western cow into the herd. 12. Carbolic acid saturation, perfected ventilation, stable room expanded and new stalls instead of old ones.

(356) 1. 1897. 2. Eight. 3. None. 4. Six. 5. None. 7. O. K. except one heifer. 8. No difference. 9. None. 10. No definite opinion. 11. Not diseased.

(357) 1. December, 1896. 2. Fourteen. 3. Two. 4. Twelve. 5. One. 6. Tuberculosis. 7. They are healthy. 8. The milk is same as before test. 9. $115. 10. Do not know of any.

The Jews might have made a mistake in the cow. I did not see her when she was killed.

(358) 1. July, 1896. 2 Four. 3. One. 4. Two. 5. None. 6. None. 7. About the same. 8. Same. 9. $40. 11. No.

(359) 1. March, 1897. 2. Sixteen. 3. Two. 4. Twenty. 5. None. 7. Much improved. 8. Improved. 9. Three cows. 10. I believe many herds to be affected. Exposure and neglect.

(360) 1. March, 1897. 2. Eleven. 3. Five. 4. Seven. 7. Good. 8. Good.

(361) 1. October, 1896. 2. One. 3. None. 4. Two. 5. None. 7. Good. 8. The same. 9. None. 10. Do not know of any.

(362) 1. May, 1897. 2. Three. 3. Nine. 4. Three. 5. None. 7. No change. 10. Have no knowledge.

(363) 1. April, 1897. 2. One. 3. None. 4. One. 5. None. 7. No noticeable change. 8. No change. 10. So far as I know there is very little.

(364) 1. March, 1897. 2. Twelve or thirteen. 3. Nine. 4. Eight. 5. Two. 6. Overfeeding; one of old age. 7. The herd is in fine condition. 8. I think it is better since test than before. Certainly it is as good. 10. There is plenty of it. 11. Never had any except one cow (young) that I bought near Jersey, but kept away from herd.

(365) 1. February, 1897. 2. Two. 3. None. 4. Two. 5. One. 7. Good as before. 8. No difference. 9. None. 10. Have not heard of any.

(366) 1. March, 1897. 2. Two. 3. None. 4. Three. 5. None. 7. All right. 8. Twenty quarts a day. 9. None. 10. Know of none.

(367) 1. May, 1897. 2. One. 3. One. 4. One. 5. Not any. 7. All right. 8. All right. 9. $35. 10. Cannot say. 11. I do not.

(368) 1. October, 1896. 2. Four cows and two heifers. 3. One. 4. Two. 5. Two. 6. Calving and constipation. 7. Appear to be in perfect health. 8. Improved if anything. 9. $25. 11. Cannot tell.

(369) 1. February, 1897. 2. Sixteen. 3. None. 4. Fifteen. 5. Two. 6. Bloating. 7. The same. 8. About the same. 10. Have no knowledge of any.

(370) 1. January, 1897. 2. Thirty-two. 3. Thirty-one. 4. Thirty-three. 5. None. 7. New Herd. 8. Cannot tell. 9. $700. 10. Pretty well stamped out. 11. Cannot tell. 12. Floors cemented and disinfected.

(371) April, 1897. 2. Fifteen. 3. Not any. 4. Eighteen. 5. Two. 6. One baked in manifold; one dropped dead; no tuberculosis found 8. About the same. 9. Not anything. 10. There were no cattle affected with tuberculosis in this vicinity when tested last spring.

(372) 1. January, 1897. 2. Five cows. 3. None. 4. Five cows. 5. None. 7. Good. 8. The same. 10. No disease has been found in this township.

(373) 1. October, 1896. 2. Six cows. 3. Two. 4. Six cows, two yearlings. 5. None. 9. $28. 10. Do not know. 11. Do not.

(374) 1. 1897. 2. Eight. 3. Not any. 4. Thirty-one. 5. Not any. 7. About the same. 8. The same. 9. Not one. 10. I think there is some.

(375) 1. October, 1896. 2. Twenty-four. 3. Four. 4. Twenty-six besides calves. 5. One. 6. Milk fever. 7. Good. 8. All young cows. Five two-year olds average over 30 pounds per day and no green food. 10. Nearly exterminated. 11. Probably from a thoroughbred cow from New York State.

(376) 1. November, 1896. 2. Nineteen. 3. Eleven. 4. Seventeen. 5. None. 7. Nearly the same. 8. The cows are a new lot. 9. $360. 10. Where they keep the cattle in the stable nearly all the time farmers will find their cattle contract tuberculosis; where they keep them in the open air they will not have tuberculosis nearly as often. 11. I used a bull purchased from the Jessup herd and in contact with the Lathrop herd; both were diseased.

(377) 1. January, 1897. 2. Twelve. 3. None were condemned. 4. Have thirteen. 5. Have lost none. 7. Condition better. 8. Milk better. 9. None. 10. Only a few cases.

(378) 1. December, 1896. 2. Fifteen. 3. None. 4. Twenty. 5. None. 7. A great deal better. 8. It is better. 9. None. 10. Not as many as has been. It is a great satisfaction to me to know that my herd is all right. Thanks to the State for it.

(379) 1. April, 1897. 2. Nine. 3. None. 4. Fifteen. 5. None. 7. About the same. 8. Same. 10. My opinion is there are more herds tuberculous than is commonly believed. I should like to see the time when every farmer would be compelled to have his herd tested. It is the only way to wipe out the disease.

(380) 1. May, 1897. 2. Eight. 3. None. 4. Eight. 5. None. 7. About same. 8. Same. 9. $30. 10. I have no means of knowing. 11. Purchased and killed within two weeks.

(381) 1. March, 1897. 2. Thirteen. 3. Four. 4. Eleven. 5. None. 7. I am feeding better and dairy is consequently doing better. 10. Not very extensive. 11. I do not.

(382) 1. February, 1897. 2. Thirteen. 3. One. 4. Fourteen. 5.

None. 7. I do not see much difference as the one killed was not far along. 8. It is about the same. 9. One cow. 10. I do not know. 11. I do not.

(383) 1. April, 1897. 2. Thirteen. 3. Not any. 4. Eighteen. 5. None. 7. I see no difference. 8. No difference. 10. None that I know of.

(384) 1. January, 1897. 2. Sixteen. 3. None. 4. Eighteen. 5. One. 6. Milk fever. 7. Better. 8. Could not see any difference. 9. None. 10. I think about 1 in 30.

(385) Spring, 1897. 2. Ten. 3. None. 4. Twelve. 5. None. 7. About the same. 8. The same. 9. No loss. 10. I think less.

(386) 1. May, 1896. 2. Eight. 3. Six. 4. Two cases. 5. None. 7. Better. 8. Better. 10. Hear very little about it. 11. From a cow that came from Lathrop's stock and he got it of Jessup's stock, of Montrose.

(387) 1. 1897. 2. Six. 3. Not any. 4. Seven cows, two calves. 5. None. 7. They are in better order. 8. The same. 9. None. 10. I do not know of any.

(388) 1. 1897. 2. Fifteen. 3. None. 4. Sixteen. 5. None. 7. About the same. 8. Same. 10. I do not think there is any. 11. They have never been affected.

(389) 1. Spring, 1896. 2. Eighteen. 3. None. 4. Fifteen. 5. None. 7. About the same. 8. About the same. 10. I do not know of any.

(390) 1. February, 1897. 2. Twelve. 3. None. 4. Fourteen. 5. None. 7. No particular change. 8. There is no noticeable change. 9. Nothing. 10. I think there are but few herds affected with it.

(391) 1. June, 1896. 2. Thirteen. 3. Not any. 4. Sixteen. 5. None. 7. Some better. 8. A little better. 10. Do not know of any cases.

(392) 1. July, 1896. 2. Ten. 3. None. 4. Three. 5. None. 7. Better. 8. Improvement in milk and flesh. 10. Not more than half as much as two years ago. 11. I do not.

(393) 1. 1896. 2. Twelve. 3. None. 4. Fifteen. 5. One calving. 7. About the same. 8. See no change. 9. Nothing. Lost two before the test; think the cause was pneumonia. 10. Think very few have it.

(394) 1. November, 1896. 2. Five. 3. Five. 4. None. 5. None. 7. All killed after test. 9. State paid the loss. 10. Cannot say. 11. Do not know.

(395) 1. December, 1896, and May, 1897. 2. In December, 1896, had 47 head; none condemned. 3. Fourteen tested, one condemned, the others sold prior to last test; 1, 2 and 3 years old. 4. Twenty-four heifers. 5. None. 7. Looking well. 8. The herd at the time of test had never given any milk. 9. $25. 10. Consilerable tubercu-

losis. 11. The cow caught the disease at H. W. Deckers' place. She was there a day of two a short time after he had 12 condemned and killed.

(396) 1. February, 1897. 2. Eight tested. 3. Two. 4. Fourteen. 5. None. 7. Never in better condition than at present for the time of year. 8. About the same. 10. Do not know. 11. Do not know.

(397) 1. December, 1896. 2. Ten cows, 3 yearlings. 3. None. 4. Ten cows, two yearlings. 5. None. 7. Same. 8. No change. 9. Nothing. 10. Do not know of any but heard of 20 or more being all slaughtered in 1896 on test, five miles from here. Think probable that ten per cent. or less would fail to test all right. 11. No.

(398) 1. February, 1897. 2. Eighteen. 3. Four. 4. Twenty-two. 5. One. 6. Milk fever. 7. No particular change. The cows were apparently in a good healthy condition. 8. The same. 9. $64 in value of cows and additional loss that can not be estimated. 10. Impossible for me to say. 11. I purchased them of a neighbor who breeds thoroughbred cattle.

(399) 1. October, 1896. 2. Three. 3. Two. 4. Two. 5. None. 7. About the same. 8. Same. 9. $60. 10. Cannot state definitely. 11. Do not know.

(400) 1. November, 1897. 2. Eleven. 3. One. 4. Ten. 5. None. 7. Healthy. 8. Good. 9. One cow. 10. Am not qualified to make an intelligent estimate. 11. I do not.

(401) 1. February, 1897. 2. Fourteen. 3. None. 4. Twelve. 5. None. 7. No change. 8. No perceptible difference. 9. None. 10. An occasional case.

(402) 1. November, 1896. 2. Nine. 3. None. 4. Ten. 5. None. 7. No particular change. 8. Same. 9. None. 10. I do not think there is much tuberculosis in this vicinity at the present time.

(403) 1. January, 1896. 2. Thirty-three. 3. Twenty-five. 4. About twenty-five. 5. Lost two. 7. Cattle that remain of my former herd are well. 8. Did not keep any account. 9. In the last 15 years, probably 40; two cows I paid $300 each for, bulls $100 each, etc. 10. It has been very prevalent. 11. I bought two cows from T. Jones & Son, Del., Ohio, and two cows from Lackawanna county, Pennsylvania. These cows brought it to my herd 15 years ago. I had never heard of tuberculosis and didn't know what it was and so it spread through my herd. 12. Mangers and floors removed, whole stable disinfected with carbolic acid and chloride of lime.

(404) 1. October, 1896. 2. Nine. 3. Not any. 4. Ten head. 5. None. 7. Better. 9. Improving. 10. I cannot say.

(405) 1. January, 1897. 2. Sixteen. 3. Not any. 4. Fifteen. 5. One yearling. 6. Blackleg. 7. About the same. 8. About the same. 10. Very little.

(406) 1. December, 1896. 2. Four cows. 3. None. 4. Three cows. 5. None. 7. My cows are in healthy condition. 8. The same as before.

(407) 1. June, 1896. 2. Eight. 3. One. 4. Twelve. 5. None. 7. Good. 8. Cannot see any difference. 9. $18. 11. From the cow we bought. Raise our own stock now. 12. Have torn out the old stables; used lime where the animal was kept.

(408) 1. January, 1897. 2. Thirty-six. 3. One. 4. Thirty-six. 5. None. 7. No change. 8. No perceptible change. 9. $43. 10. I do not think there is much tuberculosis in this vicinity at present although there is some. 11. The cows that had it were animals that I had bought, one of them from herd that had several cases of tuberculosis in it.

(409) 1. Spring, 1896. 2. Four. 3. One. 4. Five. 5. None. 7. Better. 8. Same. 11. No.

(410) 1. Fall, 1896. 2. Eight. 3. None. 4. Eight. 5. None. 7. No difference. 8. No difference. 9. None. 10. I have no idea. At the time of testing I had seven cows and one eight-months bull. Now have five cows and three two-year old heifers; two cows were beefed; saw nothing wrong in dressing.

(411) 1. January, 1897. 2. Eight cows. 3. Twelve. 4. Sixteen. 5. None. 7. Better. 8. Better. 9. $225. 10. Not any that I know of. 11. Buying cattle and bringing them on the place.

(412) 1. July, 1895. 2. Thirteen. 3. None. 4. Twenty-three. 5. None. 7. Good. 9. None.

(413) 1. March, 1897. 2. Eighteen. 3. Not any. 4. Twenty-two. 5. Not any. 7. About the same as before. 8. Better. 9. None. 10. Very few.

(414) 1. Summer, 1896. 2. Fifteen. 3. None. 4. None. 5. None by disease. 7. Continued to thrive nicely until a few days ago when they were all lost in a burning barn. 8. No harm from test. 9. None. 10. Do not hear of any trouble at present.

(415) 1. June, 1896. 2. Sixteen. 3. One. 4. Nineteen. 5. None. 6. None died. 7. All sound. 8. About the same. 9. No loss save the one condemned. 10. Very little. 11. Think by buying. 12. Stable floors and mangers all made new. All filth under floors removed and earth scraped clean.

(416) 1. March, 1897. 2. Fifteen. 3. Not any. 4. Sixteen. 5. One. 6. Probably milk fever. 7. Cannot see any change. 8. No perceivable change. 9. None. 10. Think there is some. A good many herds have been tested and some 20 or more been killed that had tuberculosis. Think there are more dairies affected, but the farmers object to having them tested.

(417) 1. April, 1897. 2. Eight. 3. None. 4. Twelve. 5. None. 7. The same. 8. The same. 10. Not much.

(418) 1. April 27. 2. Twelve cows. 3. None. 4. Twelve. 5. None. 7. About the same. 8. The same. 9. None.

(419) 1. January, 1897. 2. Six. 3. Not any. 4. Six. 5. Not any. 7. The same as previous test. 8. About the same.

(420) 1. In 1897. I had no tuberculosis; no symptoms of any. No loss of cattle before or since.

(421) 1. April, 1897. 2. Seven. 3. None. 4. Nine. 5. One. 7. Three per cent. better. 8. None. 9. None.

(422) 1. November, 1896. 2. Eighteen. 3. None. 4. Twelve. 5. None. 7. Very thrifty now. Their cough and low condition due to feeding rusty oats. 8. Much better since. 10. Do not think there is a case here. 12. Radically; new barn, cement floor, swing stanchions, etc.

(423) 1. March, 1897. 2. One. 3. None. 4. One. 5. None. 8. Can not notice any change. 10. Do not know of any cattle in this vicinity infected with it.

(424) 1. April, 1897. 2. Four. 3. Three. 4. One cow. 5. None. 6. I think the cow that I killed before communicating with the State Board had tuberculosis and all had the same disease. 7. The only cow is in good condition. 8. Four gallons per day but did not use milk. 9. $180. 10. There may be some cases but know of none. 11. Through breeding.

(425) 1. March, 1887. 2. Eight. 3. None. 4. Six cows, six calves. 5. None. 7. About the same. 8. About the same. 10. It might be well to test some of the cattle of our vicinity.

(426) 1. March, 1897. 2. Thirty-two. 3. Fourteen, including one of neighbor. 4. Twenty-seven head. 5. None. 6. No disease. 7. No difference. 8. The same. 9. $600. 10. From past experience in tests, think there is more of it in this vicinity. 11. Do not know, but think from herd killed two years before on joining farm.

(427) 1. May, 1897. 2. One. 3. One. 4. One. 5. None. 7. I have one apparently healthy cow but did not have her when the other was condemned. 9. About $30.

(428) 1. May, 1897. 2. Fourteen. 3. None. 4. Eighteen. 5. None. 7. About the same. 8. Not much difference. 10. Several cases around here.

(429) 1. April, 1897. 2. One. 3. None. 4. Two. 5. None. 7. Same. 8. No change. 9. None. 10. Cannot say. 11. Not infected.

(430) 1. May, 1897. 2. Eleven. 3. None. 4. Eleven. 5. None. 7. Same.

(431) 1. April, 1897. 2. Twenty-one. 3. One. 4. Forty. 5. None. 7. The same. 8. No change noted. 9. $75; this was a young bull that we sold to an institution in Philadelphia subject to test. He showed but a very slight trace of tuberculosis. 10. There is not

much. 12. The bull was the best calf of a cow whose dam was imported; being of a very popular and fine family, we kept her much longer than we should have otherwise done. She was old and worn out; the calf sucked her as long as she lived and we now think may have contracted the disease in this way. Having no other case leads me to this conclusion.

(432) 1. October, 1896. 2. Forty-seven. 3. Twenty-five. 4. Sixteen. 5. None. 7. Much better. 8. Twenty per cent. more now. 9. Lost four; State killed twenty-five. 10. I think a good many cattle are infected. 11. By buying stock from Allentown.

(433) 1. May, 1896. 2. Twenty. 3. Nine. 4. Five. 5. None. 7. much better. 8. Have but one cow; cannot tell. 9. $500. 10. Cannot say there is any. 11. From a cow bought in another part of this State.

(434) 1. September, 1897. 2. One. 3. Not any. 4. None. 5. None. 9. $100.

I have no cattle at present, having sold the last one a few weeks ago. I had four as good cows as any one in this section until tuberculosis got hold of them and the first one died and I did not know what was the matter with her, the second one died and was opened by an old cow doctor, who said that tuberculosis killed the cow. The third one was tested. The inspector examined my cows in April, 1896, and condemned one and afterwards killed and dissected her and buried her, and the State paid me $20. The last one was tested in September, 1897, and was pronounced all right. She is a fine young cow and has all appearance of being in perfect condition. She is now owned by Mr. Smith; his cattle were all tested the same time my last one was and were healthy. There are but few cattle around here that have not been tested. I think the disease is nearly run out, as nearly every farmer has taken hold of it.

(435) 1. June, 1897. 2. Twenty-eight. 3. None. 4. Fourteen. 5. None. 7. Same. 8. Same. 9. None. 10. I do not think there is much.

(436) 1. April, 1896. 2. Fourteen. 3. None. 4. Seventeen. 5. Two. 6. One choked on apples and one died of calving. 7. About the same. 8. Same. 9. None. 10. I know of none. 11. Never have been

(437) 1. January, 1897. 2. Twelve. 3. Not any. 4. Seventeen. 7. Same. 8. Same.

(438) 1. June, 1896. 2. Nine. 3. None. 4. Ten. 5. None. 7. The same. 8. One hundred and ten quarts per day. 9. Nothing.

(439) 1. March, 1896. 2. Eighty. 3. Fifty-nine. 4. Thirteen. 5. Four on retest. 6. Tuberculosis on retest of herd. 7. Better. 8. About the same. 10. Do not know of any. 11. By purchasing animals from New Jersey.

(440) 1. March, 1897. 2. Ten. 3. None. 4. Seven. 5. None. 7. Good. 8. Same. 10. I know of none being affected.

(441) 1. April, 1897. 2. Seven. 3. Four. Two head died before inspection was male. 7. Good. 8. Excellent. 10. Decreasing. 11. Yes. By buying a cow that had the disease and not knowing it at the time.

(442) 1. Fall, 1896. 2. Fourteen. 3. Ten. 4. Six, and thirteen fattening. 5. None. 7. They are looking well and healthy. 8. Fifty per cent. more. 9. $300. 11. Through purchasing two cows from a diseased herd. My barn burned down July 26, 1897, and three or the four that were not diseased when tested, perished in the fire. Since I rebuilt the barn I purchased three young cattle and two milch cows and in December I had four head tested and the veterinarian found them all right.

(443) 1. July, 1896. 2. Four. 3. Four. 4. Two. 5. None. 6. Tuberculosis. 7. Had four die before the test. 9. $350.

(444) 1. September, 1896. 2. Thirty-three. 3. Twelve. 4. Thirty-five. 5. None. 6. No answer required. 7. Physically the same, but believe no tuberculosis to exist. 8. Under normal comparative conditions it is slightly increased. 9. Can not give number. In 1884 altogether.) 10. Since the beginning of the State examination naturally there has been a decrease but there is still, in my opinion, many herds infected. This certainly can not be rectified until the State adopts a compulsory system with ample appropriation. 11. I can trace almost directly the infection of my herd. In the original purchase of Jersey cattle I was limited to those imported from the Island. No tuberculosis was detected in these animals. I have in fact two animals in my herd for sentimental reasons that were bought in 1883 just from the Island, which have passed two tests. In 1884 I purchased a bull and two cows from the Darling herd at Kellog sale and paid $3,000 for the bull and a like amount for the two cows. I can assert with some degree of positiveness that from this purchase my herd became infected. The bull and cows were all killed by me and all were seriously infected. The animals were of the Rioter strain and were very highly inbred. I am inclined to think that the close inbreeding for the purpose of increased butter production by "artificial selection" has, in the Jersey, resulted in emphasizing the heredity tendency of the Island cattle to tuberculosis. 12. My cow stable is a separate building, standing by itself. It was thoroughly cleaned, all loose boards and walks torn up, stalls, mangers, etc., thoroughly scrubbed with a strong solution of lye, and then disinfected with chloride of lime solution, then all wood-

work whitewashed, including ceiling. The stable was not occupied for a month. New walks were laid and it is now cleaned and whitewashed frequently.

(445) 1. March, 1897. 2. Five. 3. None. 4. Five milch cows. 5. None. 7. Good; better than before test. 8. Milk is better. 9. $35. This was, however, before test. 10. Do not know of any. 11. Through buying stock.

(446) 1. March, 1897. 2. Twenty-seven. 3. Three. 4. Twenty-four. 5. None. 7. Good. 8. Increase a little. 11. Think it came from a heifer brought from State of Maryland as she was the worst diseased one of the three killed.

APPENDIX.

TUBERCULOSIS OF CATTLE.*

By PROF. B. BANG, *Copenhagen, Denmark.*

I have been asked to write for publication in Pennsylvania, a paper discussing some points concerning tuberculosis of cattle on which, I am told, it is useful to enlighten the live stock owners of that State. It was thought that the experience I have gained from my long occupation with these questions, might perhaps contribute to a closer understanding of tuberculosis of cattle, and the means to combat it.

In trying to fulfil this wish, I think it best to keep close to the following subjects:

1. The desirability of having herds freed from tuberculosis.
2. The transmission of tuberculosis between cattle stabled and herded together.
3. The value of good sanitary conditions, light, cleanliness, ventilation, etc.
4. The effect of tuberculin on healthy cattle.
5. The propagation of tuberculosis among swine, calves, other animals and people, through the milk.
6. The accuracy of the tuberculin test.
7. The success of the work directed against tuberculosis of cattle in Denmark, and the favorable manner in which these operations are accepted by the owners of live stock.
8. The advantages which will accrue from the suppression of tuberculosis among cattle.

*[Professor Bang, the author of this paper, is a member of the faculty of the Veterinary and Agricultural College of Denmark, located in Copenhagen, and is the chief veterinarian of his country. He is one of the greatest specialists on tuberculosis of cattle and has originated and conducted a plan for repressing this disease that is more successful than any measure for this purpose that has been adopted by any other country in Europe. His plan is conservative and aims to repress the disease with a minimum of loss. It is especially valuable in countries and localities where the frequency of tuberculosis is high, where milk that has been heated can be disposed of profitably, and where a safe system of meat inspection is in operation at the slaughter houses.

This paper was prepared for and was printed in the Annual Report of the Pennsylvania Department of Agriculture for 1897, and is here reprinted on account of its great and permanent value. The date of the preparation of this paper (1897) should be born in mind.—L. P.]

1. AS TO THE DESIRABILITY OF HAVING HERDS FREED FROM TUBERCULOSIS.

At first this question may seem a superfluous one, but on further reflection its importance is plain. It is clear that the stock owner who loses one or several cows from consumption, or sees the animals emaciate instead of fatten, needs no explantion as to the desirability of being freed from a scourge which causes such evident losses. But the fact is, that tuberculosis can exist, can even have gained a considerable extension in a herd and yet for a long time the owner may have very little notion of this calamity. Tuberculosis—unlike anthrax, which causes every individual attacked to be violently diseased and usually causes death in the course of a few days—is a very insidious illness that begins quite imperceptably and will often for a long time keep completely hidden. This latent character of the illness is indeed no exception, it is on the contrary the rule. By tuberculin tests you will sometimes see three-fourths or almost all the animals of a herd reacting, thus revealing themselves to be infected with tuberculosis, though they are looking quite sound. I even know cases, where the owner of such stock maintains never to have perceived the least traces of the disease. Now such a man might doubt whether it be worth while to make sacrifices to get rid of a disease which apparently does so little harm. Of course such cases are rare where no disease at all has been detected in infected herds, usually some cow or other will be unthrifty or thin, but most farmers are accustomed to have misfortune occasionally, and if this does not happen too often it will not annoy them seriously.

It is this insidious progress which explains why tuberculosis has in most countries attained such an enormous extension. It does not excite immediate attention. In all countries in which it has been possible to follow the history of the disease, and to ascertain with some accuracy the date and ways of its introduction, as for instance Denmark, Sweden and Finland, you will find that at first it has not caused great trouble, and that years have passed before much has been spoken of it, and the same thing happens in every herd into which it is nowadays introduced. But gradually the losses sum up, and it develops into a positive scourge. And in many infected herds the losses will occasionally be very great. Sometimes it is not easy to see what has made the disease progress rapidly in so many infected animals, sometimes the cause may easily be found. Thus an acute contagious disease will sometimes be followed by a rapid development of tuberculosis in infected cattle. I know a large farm with about 200 head of cattle in Denmark, where tuberculosis was known, but had never appeared to be of a malign character; in 1893 the herd was infected with foot and mouth disease, and after this tubercu-

losis made such progress that in the course of the following years the owner had to slaughter about 50 head of cattle, part of which were in a very reduced state.

Thus it will be evident to the intelligent farmer that he must at some time free his herd from a disease continually menacing him with great losses. If he has not himself suffered from the scourge of tuberculosis, he will know neighbors who have suffered severely from it, and he must consider that the same fate may be his. Another circumstance of more recent date will arouse his attention. Since it has been ascertained that consumption in man depends on the same cause as tuberculosis in cattle, a fear has arisen in all countries that this disease so fatal to man, which in most countries causes one-seventh, in some places even one-fourth of all deaths, may have one of its sources in animal tuberculosis. Nor is this fear without foundation, although it is often exaggerated. Even if the farmer does not care to subdue tuberculosis on account of the losses caused by the sickness and death of his cows, he will be obliged to take an interest in this matter on perceiving the difficulty of selling the milk or the meat derived from cattle more or less tubercular.

2. AS TO THE TRANSMISSION OF TUBERCULOSIS BETWEEN CATTLE STABLED AND HERDER TOGETHER.

It is quite impossible for an animal to get tuberculosis without the tubercle bacillus being admitted into its body. These are pure parasites which do not develop outside of the animal body. From a tubercular animal they can be exercised in different ways—by expectoration, with the manure and urine, with the milk, with discharge from the genital organs, etc.; and when they have left the body which has housed them, they can keep alive for rather a long time, though rarely more than half a year, and infect another animal or man by being admitted to his body. It is only under special laboratory conditions that the tubercle bacillus can be brought to propagate itself outside of the body, and thus we are sure to be right in maintaining that all the tubercle bacilli which we encounter on our way must have been excreted by a sick animal or a sick man. They are, therefore, not found everywhere, but only where tubercular animals or men are living or have lived recently. Hence, the danger of becoming infected with them is far greater in closed places (rooms or stables) than in open fields, where the germs are diffused so that only a few occur in a given place, and where they will, comparatively, soon be destroyed by natural influences, especially the sunlight. The smaller, darker and closer the room is, the greater the probability that sound individuals will be infected. That it must be so we may know beforehand and that it is so experience teaches us, as regards

both men and animals. That tubercle bacilli are not found everywhere is clearly shown from the fact that in countries where tuberculosis is common, many herds will be found completely exempt. This is proven not only by the fact that the owner has never perceived any trace of it, but the tuberculin test shows that not a single animal reacts. I ascertained some years ago in Denmark that more than one-fifth of the examined herds prove to be quite free from tuberculosis, and afterwards the same thing was observed in many other countries, as, for instance, in Pennsylvania. And in Denmark, at least, many of these herds are comparatively large, embracing 40 to 50 individuals. These are almost always herds which have been bred and reared on the farm and to which, for many years, no new animals have been introduced. I have shown that some of these herds were made up of cows in which the milk yield is developed to the highest degree, so that according to old views, the animals must be supposed to be highly predisposed to tuberculosis, but no contagion had been introduced, and accordingly there was no disease.

Thus it is contagion on which everything depends and contagion occurs chiefly by association in the stable with tubercular animals excreting tubercle bacilli. Of course there are other ways by which it may be transmitted and of these feeding with tuberculous food, especially with infected milk, is the chief one. Also, copulation may sometimes transmit contagion when tuberculous affection combined with the discharge are found in the genital organs. Tuberculosis may also be transmitted from the mother to the foetus through the placenta (perhaps also from the male animal to the egg), but congenital tuberculosis is comparatively rare.

Yet this form of contagion is not quite so rare in cattle as many, for instance Nocard, consider it to be. I have especially directed my attention to this question, and in the course of eight years, mostly by the help of several veterinary surgeons at slaughter houses, have been able to gather not less than 85 cases of congenital tuberculosis, partly in foeti, partly, and these cases were the most common, in new-born calves.* But the tubercle bacilli can only be transmitted from the mother to the foetus through the blood—if the uterus of the mother be not affected by tuberculosis—and, therefore, foetal tuberculosis is only found in calves whose mothers are highly tubercular, as only such individuals have tubercle bacilli in their blood. Cows that have only local tuberculosis (for instance of lungs, bronchial or mesenteric glands) cannot contaminate their foeti. Thus the great majority of tubercular animals will bear sound calves. It is precisely on this fact that I have founded my system of combating tuber-

* These tuberculous deposits are as a rule very small and calcified. They are to be found in the liver and, especially, in the portal glands. Generally you will also find some deposits in the mediastinal and bronchial glands, sometimes also in the lungs, the spleen and other organs.

culosis—which purposes to raise calves born by sound looking cows, even if the tuberculin test has proved these to be already infected with the disease, but to remove the calves from the mother's stable as soon as born, place them in a locality free from contagion and give them boiled milk or milk from absolutely sound animals.

On the basis of my experience I believe I may say, that congenital tuberculosis will not even be found in one-half per cent. of the calves of a tuberculous herd.

Contagion through infected milk plays a very large part, and according to my experience, is the essential cause of tuberculosis in young calves, but this cause will only work the first year at most. After that time the calves, at least in Denmark, get no milk. And as tuberculosis is a disease the frequency of which increases largely with age, it is clear that we cannot accuse milk of being its chief cause. It is evident that year by year the cattle pick up contagion with more and more frequency, and the chief source must be the tubercle bacilli disseminated in the stable by other tubercular cattle. In itself it is of no great consequence whether we suppose the tubercle bacilli to be chiefly admitted through the digestive organs or the respiratory organs. Both ways are possible. The food and the water may be infected by expectoration and discharge from the nose or by bacilli attached to particles of dust or the cow may lick objects (walls, cribs) which are contaminated with evacuations containing bacilli, or inhale tubercle bacilli attached to particles of dust. As showing the first method of transmission it is often noticed that a newly bought sound cow will strikingly often become affected with the disease when it is put in a place occupied shortly before by a badly tubercular cow (if the place has not been thoroughly disinfected), and also that the disease very often passes to the nearest neighbor of a sick beast. But contagion through the air, no doubt, also plays an important part. The great frequency with which tuberculosis is found only in the lungs and the bronchial glands, speaks strongly for contagion through inhalation. My experience also points strongly in the same direction, for many and many a time I have observed that transmission is not avoided by placing the sound animals in one end or one one side of the stable, while the tubercular cattle are placed at some distance from them and are without any direct communication with them. If you will avoid the dangers accompanying association in the stable, the sound animals must be entirely removed from the diseased ones and placed by themselves.

In pastures the danger of contagion will be far less than in the stable, especially when the cattle are tethered, as is the case in Denmark. When the cows are not tethered they may of course communicate the infection by licking each other or by drinking from the

same receptacle. I know some places where tuberculosis seems to have been caught on the pasture; so when sound and reacting animals are on the same farm they ought to be kept in different fields.

3. AS TO THE VALUE OF GOOD SANITARY CONDITIONS, LIGHT, CLEANLINESS, VENTILATION, ETC.

On this point I can be brief, referring to what Dr. Leonard Pearson has written in the second annual report of the Pennsylvania Department of Agriculture.

The importance of cleanliness in the stable is easily to be understood. If animals excreting tubercle bacilli with the faeces or with discharges from nose, mouth, vagina, etc., are found in the stable, it is clear that the danger of contagion is very much diminished, when these things are quickly removed and are not allowed time to dry into dust. The better the ventilation, the less the number of germs floating in the air and the less probability of their infecting a sound animal. It has also been proved that the danger of development of disease is greater when many bacilli than when few are admitted to the organism. The light of the sun is the most efficient natural means of disinfection, and a light stable will more easily be kept clean, for the dirt will be noticed.

But fresh air, light and good food, i. e., good sanitary conditions, are also of the greatest importance in giving animals as well as man resisting powers against the germs of disease admitted to the body. They cannot exactly prevent the animal from being infected, but the better the sanitary conditions are, the greater the probability that the animal will be able to confine the tuberculosis to the first organs infected or their lymphatic glands, where the bacilli have entered, arriving thus at the result, which is luckily not uncommon, that for a long time—perhaps for many years—the tuberculosis will remain an insignificant affection, which does not prevent the cow from giving sound milk, sound meat and sound calves.

4. AS TO THE EFFECT OF TUBERCULIN IN HEALTHY CATTLE.

Tuberculin is a preparation which cannot contain living bacilli. To be sure it is made of beef tea in which the bacilli have been grown, but the culture has been subjected to prolonged heating at 115 degrees C., which absolutely kills the bacilli and, next, the dead bacilli are removed by filtration. Thus it is evident that the injection of tuberculin cannot call forth the disease in sound cattle. A fear has been expressed that tuberculin might give rise to an acute blazing up of tuberculosis in tubercular animals, thus causing animals which had before appeared comparatively sound to become seriously

affected by the development of an acute miliary tuberculosis, as was at one time supposed to be of frequent occurrence in human tuberculosis. But I can prove that as to cattle this at most, happens very seldom.

In Denmark we have several large herds in which 100 to 200 cattle —in one even 350—reacted two to four years ago. These reacting animals have been allowed to live, they have, however, been separated from the sound cattle, and it is evident that in these reacting sections the disease has not progressed at a more rapid rate since the test than before. Several owners even maintain that it has progressed less rapidly. Of course, in such a herd the disease will naturally reach an advanced development in some individuals, but this would have happened even if no tuberculin test had been made. Only a few farmers mention that they have the impression that the disease has made great progress in an occasional individual some time after the test; but such single observations may depend upon accidental coincidence, it is absolutely not the common rule. If it has happened frequently it would, of course, have awakened the attention of the farmers, and it is quite impossible that tuberculin could have been used in always greater measure year after year if the test had frequently been followed by aggravation of pre-existing disease.

5. AS TO THE PROPAGATION OF TUBERCULOSIS AMONG SWINE, CALVES, OTHER ANIMALS AND PEOPLE THROUGH THE USE OF MILK.

That the milk of the tubercular cows is liable to propagate tuberculosis to calves, swine and other animals, is an observation I have often made. Several years ago I reported that by the autopsy of 34 milk fed calves reacting by the test of two large herds, I found that in 24 of them the disease was evidently due to infection through the food. In these cases tuberculosis was found only in the lymphatic glands of the throat or mesentery, in the walls of the intestinal canal or, at least in these places it was of oldest date. And since that time I have made numerous similar observations. In Denmark, the swine are almost always fed with skim milk, buttermilk and whey in addition to grain, and formerly it was often noticed that when these milk foods were given raw (unboiled or insufficiently pasteurized) the swine almost always suffered from tuberculosis, where this disease was very prevalent among the cows. The oldest centres of tuberculosis were here to be found in the lymphatic glands in the neighborhood of the throat.* In Denmark, milk is often given to young

* Since attention has been directed to this danger, tuberculosis in swine has greatly diminished in my country.

horses or to sick horses, and in those parts of the country where this custom is frequent, tuberculosis is not rare in the horse. This animal, when infected with tuberculosis, always has tuberculosis of the digestive tract. A few ulcers are found in the small intestines and enormous tuberculous infiltration in the mesenteric glands, sometimes also in the lymphatic glands of the throat. The disease gradually spreads with the blood, but it is easy to see, especially in the lungs, that these other formations are secondary. To cats and dogs the disease is also sometimes transmitted through the milk; nor can there be any doubt, that by this means it is not infrequently transmitted to man, especially to little children.

In Denmark we have a peculiar system which throws a clear light upon the importance of milk as a source of contagion. From almost all smaller farms the milk is daily sent to common creameries where butter is made. Cheese is sometimes made of the skim milk, but the greater part of it is sent back to the farm, where it is used as food for calves and swine. Of course the various farms do not get back their own milk, but part of the mixed supply. Now, if among the farms furnishing milk for the creamery some are found whose cows are greatly tubercular, tubercle bacilli may be brought with the skimmed milk to a sound herd and formerly this happened frequently. By tuberculin tests it has in some cases been found that all the adult cattle were sound, while some calves reacted, quite the reverse of the usual case, which is that the disease prevails to a greater extent in old animals than in young ones. This is undoubtedly the consequence of contagion through the milk. In many cases, indeed, it has been shown that the disease is found only in animals that have consumed milk at a time when the apparatus for pasteurizing did not work properly. Nowadays, as a rule, the danger in question is avoided by the skim milk being heated to a high degree before leaving the dairy.

Is then all milk of tubercular cows virulent? By no means. Luckily this is only an exception, but no rare one. The greatest danger, as is well known, is attached to the milk from a tubercular udder, and this ailment is a very dangerous source of tuberculosis for man, because at the beginning of the disease the tubercular udder—often even almost a month after the appearance of a hard tumor—secretes milk of almost natural appearance, which people will often be tempted to use. But, also, when no tuberculous deposits can be pointed out in the udder, the milk may contain tubercle bacilli if the cow suffers from advanced generalized tuberculosis, so that tubercle bacilli now and then circulate in the blood. I have previously reported experiments I made by inoculating rabbits and guinea-pigs with milk from 63 highly tubercular cows with appa-

rently sound udders, which showed that nine of these animals secreted virulent milk. As long as the cow has only a limited tuberculosis—as is luckily the case with the majority of reacting animals—it will not secrete tubercle bacilli with the milk. But in a large herd of tuberculous cows it will probably almost always be found that some one secretes virulent milk on account of having either tuberculosis in the udded or generalized tuberculosis.

The danger of contagion through the milk can always be avoided by boiling it or by heating it to 185 degrees F. Even the influence of a somewhat lower temperature—167 degrees F. to 176 degrees F.—will diminish the danger very much, as I have found that so far as rabbits are concerned, milk heated to these degrees could infect by injection into the abdominal cavity, but not by feeding. We therefore in Denmark always recommend either boiling or heating to 185 degrees F., if the milk is to be given to calves, and we are not sure that it is derived from entirely sound cows. Experience shows that the more carefully this heating is performed, the greater security against the propagation of tuberculosis to these animals and to horses, swine, etc. Each year this is performed in a better manner. At present a bill is before our parliament to prohibit all creameries from returning skim milk and buttermilk that has not been heated to 185 degrees F. It is also proposed that cows with tuberculosis of the udder are to be killed and the owners receive compensation from the State.

Little children usually get boiled milk in Denmark and in Copenhagen, and in several other towns are concerns selling milk that has been heated to exactly 185 degrees F. When such milk is immediately cooled by ice, it does not get the cooked taste, to which many people are so averse.

Like skim milk, buttermilk and whey, the butter too may contain tubercle bacilli. Luckily this happens less frequently at least when, as in Denmark, it is made of cream which has been separated from the milk by centrifugation, as most tubercle bacilli are thereby thrown out of the milk* Excellent butter can be made of cream heated to 185 degrees F. or even to a higher point.

6. AS TO THE ACCURACY OF THE TUBERCULIN TEST.

The introduction of tuberculin marks a most remarkable advance in the diagnosis of tuberculosis, as it enables us to discover the presence of the disease in the earliest stages, and in very slightly developed forms. But it has three essential disadvantages. In the first place the violence of reaction has no constant relation to the development of the disease. Farmers often believe the cow reacting

* And every possibility of danger can easily be avoided by pasterizing the cream before churning as now-a-days is done almost everywhere in Denmark.

violently to be extremely tubercular and the one reacting feebly to be comparatively sound. The case is rather the reverse, but this is not constant either. Next, tuberculin is not absolutely to be relied upon. To be sure you will very seldom be mistaken in the conclusion that a cow, which has shown an evident reaction, is indeed tubercular. I, for my part, know only three or four cases in which I could find no tuberculous deposits in such an animal, and in these cases the fault may be mine and not that of tuberculin, as it is impossible to examine every part of the body of a slaughtered animal. The tubercles may have been hidden in an unusual place, or they may have been so small or so fresh, that they could not be discovered. This case then is a very rare one, though the unskilled observer, for instance, the butcher, may believe it to be a frequent one. Moreover, it must be considered that it would not be a disaster even if a sound animal should for once be considered tubercular. Far more frequent is the case that an animal which has not reacted, is proved by slaughtering to suffer from tuberculosis. But usually this has not the practical importance one would suppose it to have, as in the great majority of cases the deposits in question are very small, very old or greatly calcified, indicating that the process has become stationary. Experience teaches that such small deposits usually keep quite unchanged for a series of years, and may even at length be healed. In fact, animals which have this form of tuberculosis will be quite harmless to their associates as they do not excrete tubercle bacilli. But there are also cases in which an animal suffering from far advanced and very contagious tuberculosis does not react to tuberculin. This is a very provoking fact; luckily, however, it happens but seldom, and we must be taught by it not to rely on tuberculin alone, but to have recourse to clinical examination which will usually enable us to detect tuberculosis in such advanced forms. In the third case, tuberculin has the imperfection that reiterated reactions will not rarely call forth a temporary insusceptibility to the substance so that tubercular animals will at length cease reacting to a new injection. This circumstance may occasion fraud in dealing in cattle, but as the fact is very inconstant the imposture will by no means always be successful.

Insusceptibility to tuberculin is most apt to follow the repetition of the test at short intervals, but it may also be seen when a whole year has elapsed between tests. In these latter cases according to my experience, the disease will almost always be insignificant. Nevertheless, when —as in Denmark—tuberculin is employed in order to divide a herd in two sections, one sound and one reacting, the latter should not be tested more than once, that uncertainty may not be created by the failure of the reaction in some animals upon renewed tests. Such animals ought to remain in the section to which

they have originally been conveyed, for even if most of them are not dangerous at the time, you cannot be certain that the small latant tuberculosis may not blaze up.

But the imperfections of tuberculin mentioned here are eclipsed by its good qualities. According to my experience which is founded on a very great number of autopsies, it is in 10 per cent. of the cases at most that tuberculin will be at fault (the immunity after reiterated reactions not taken into consideration), and it is only in a very small percentage of these cases that the fault will be of consequence. Tuberculin, therefore, in spite of its imperfections, marks an immense advance in the diagnosis of tuberculosis. By its help we are able to discover a great number of cases of tuberculosis, which were formerly absolutely concealed. Until something still better has been found, we must consider it to be our best weapon in the struggle against tuberculosis of cattle.

7. AS TO THE SUCCESS OF THE WORK DIRECTED AGAINST TUBERCULOSIS OF CATTLE IN DENMARK AND THE FAVORABLE MANNER IN WHICH THESE OPERATIONS ARE ACCEPTED BY THE OWNERS OF LIVE STOCK.

That owners of live stock in Denmark have been very willing to make use of tuberculin is clearly proved by the great number of tested animals. In April, 1893, an act was passed placing 50,000 kroner per annum (about $12,000)* at the disposal of the Government in order to make it possible to distribute free tuberculin and pay the veterinary surgeons for making the tests (injections and measuring of temperature) on the herds of owners who promised to employ the remedy in a rational manner, that is, who promised to separate the animals not reacting from those reacting or not tested. Quite exact statistics as to the number of animals which were under this provision in each of the following years cannot be given, but on calculation from the quantity of tuberculin which has been sent out to the veterinary surgeons, there have been injected about:

	Young Cattle.	Adult Cattle.	Total.
In the fiscal year 1893-4 about,	4,800	450	5,250
1894-5 about,	11,000	6,800	17,800
1895-6 about,	32,200	33,000	65,200
1896-7 about,	49,000	44,000	93,000

Up to the summer of 1897, I had received reports of test of 158,911 animals in 5,733 herds, and since that time many injections have been made. Denmark has about the same number of cattle as Pennsyl-

* Since 1896 100,000 kroner.

vania, about 1,700,000 cattle of all kinds, including about 1,000,000 milch cows. We can estimate that from 8 to 9 per cent. of the cattle have been tested in the last years. Now if it is asked whether all the stock owners who have had their cattle tested at the cost of the state have fulfilled the promises given as to the separation of sound from reacting animals, the answer must be: No, not all; but most of them have at least tried to do it as well as circumstances would allow. As the test is given freely, no matter whether evident traces of tuberculosis have been observed in the herd or not, many herds have been tested in which all animals were proved to be sound. This applies to 22 per cent. of the tested herds. In many others, only a few animals reacted, and it has often been easy to put such animals in a separate place till they could be sold. In those cases in which almost all grown up animals reacted, while most of the young cattle were sound, it has often been possible to place the latter in a particular stable for young cattle, as such a one can easily be made if it is not previously at hand. The greatest difficulty of isolation occurs when there is both a great many diseased as well as sound adult cattle. In this case it has usually been necessary to divide the stable by a solid partition. But not unfrequently the construction of the stable has been such that it was necessary to have doors in the partition to allow feeding or removal of the manure. This arrangement is not a good one, as there is too much opportunity for contagion even if the doors are kept shut during the time when not in use. Though the result has often proved by the renewal of the test to be a good one, even under such circumstances, I know many cases in which such an imperfect separation has proved insufficient. But when the sound animals have been placed in stables which were indeed completely isolated, and especially in different buildings, the result has usually been very satisfactory. The best manner of isolation is, of course, to place the sound animals on another farm from that occupied by those which have reacted.

The method which according to my recommendation is used in Denmark to combat the tuberculosis of cattle is very moderate. It does not aim at exterminating the evil with one blow, but strives to reduce it gradually. It takes it for granted that animals reacting to tuberculin but showing no evident clinical signs of tuberculosis, are in the majority of cases affected but to a limited extent, and that therefore it is not necessary to kill them. They may live and keep apparently healthy for years, their milk, as a rule, does not contain tubercle bacilli and by pasteurization every danger of contagion can be avoided. Their flesh also will generally be safe for food and by control of the butchering, those carcasses which might afford danger of contagion can be withdrawn. And in the immense majority of cases they will give sound calves. Thus, generally, there is no reason for

killing a sound looking animal only because it has reacted, it may continue to live and be used as before, and the herd may be maintained by self-breeding. But as among reacting animals there will always be some subjects in whom the disease develops so that it will become a bearer of contagion, the reacting animals must always be separated from the sound ones as thoroughly as possible. The newborn calves must immediately be removed from the stable where the reacting cows are placed, and they must have boiled or pasteurized milk. The sound section ought to be tested with tuberculin at least once every year in order to enable us to remove the animals which may have got tuberculosis in spite of the separation.

As an instance of the result which may be attained by carrying through consistently the method just outlined, I shall name two farms where the separation has been brought about in a very simple manner by dividing the large common cow stable by a partition, by employing different sets of attendants for the two sections and by making the two sections use different pastures in the summer. The first of these farms is Thurebylille, where I first introduced the system in the year 1892, the second is a farm in Jutland, where we began in 1894. On the first of these farms, the common calf stable communicates with the sound section, on the second the calves and the young cattle are placed in different buildings on the same farm. In both places, tuberculosis was at first widespread, but not very malignant, as the number of animals which had to be slaughtered as obviously diseased was not large. It will be seen that in the course of these years a large sound herd has grown up by raising the calves, born partly of sound mothers, but in the first years, for the greater

Thurebylille.	Reacting section.	Sound section.	Animals which reacted in the sound section.
April, 1892,	131	77	..
October,	..	77	7
May, 1893,	90	103	10
October,	..	107	1
April, 1894,	87	122	2
October,	..	119	1
May, 1895,	69	136	3
October,	..	132	2
May, 1896,	54	149	7
October,	..	147	7
May, 1897,	48	155	6
October,	..	157	2

Farm in Jutland.	Reacting section.	Sound section.	Animals which reacted in the sound section.
January, 1894,	139	86	..
December,	..	114	8
May, 1895,	..	117	1
October,	..	140	2
April, 1896,	..	148	4
October,	..	153	3
May, 1897,	..	184	5
November,	64	169	6

part, of reacting mothers. The racting section, in the course of years, has been diminished by gradual removal so that at Thurebylille it has diminished from 131 to 48, on the other farm from 139 to 64, and in the course of a few years this section will quite disappear. On Thurebylille I have been able to closely follow these isolated animals and have myself re-examined almost all of them at slaughtering. In some of them, the disease has no doubt made progress and a few have been condemned by physical examination, but most of them were capable of being used for food and in many of them, tuberculosis has proved to be very insignificant and greatly calcified, conveying the impression of having remained quite stationery for several years. Of the animals sold from the farm in Jutland, I know that they have not often caused their proprietor any loss.

Nevertheless it will be seen that in spite of the separation every year several animals have fallen by renewed test of the sound division, some years very few, some years more. So by this separation we have not succeeded in absolutely excluding from the sound section every trace of contagion from the reacting one. But this cannot be expected when the two sections are so near each other; there are too many probabilities of transmitting contagion through various vehicles (people, dogs, cats, rats, etc.), perhaps also through food, as in Danish stables the common hayloft is usually above the stable. But the progress is considerable.

On a great many other farms where this work has been carried on for a longer or shorter time in the same manner, the result is quite similar. Where the division has been fairly good it is about the same as here, where less care has been taken or where there has been a door in the wall the result is, as a rule, not as good, but where it has been possible to place the two sections in quite different buildings or on separate farms it is usually much better.

All things considered, I believe it to be beyond doubt that the whole movement has been a very useful one.

A precise statistic statement which could prove how great the progress has been I am not able to give, partly because my time has been too occupied to allow me to exactly revise the great mass of material. Also in the greater majority of herds the tests have been made in the last year so that the results are not yet at hand. But different preliminary summings up clearly indicate a pronounced amelioration. The increasing demand for tuberculin tests at the expense of the state also indicates that the farmers are on the whole satisfied with the results which they see.

We are then progressing, but still we are far from the end, and though the mild method applied here had undoubtedly proved to be of good use, I will by no means maintain that more could not and ought not to be done. I have already mentioned that at present it is planned to require by law the heating of all skim milk and buttermilk in creameries, and the killing of all cows with tuberculosis of the udder. But I am also endeavoring to provide for the awarding of some sort of premium on a prompt examination of cattle infected with tuberculosis of a contagious character as well as with tuberculosis of the udder that is, tuberculosis of the uterus, of the intestines and advanced tuberculosis of the lungs. The plan is to provide for a partial compensation to be given for such animals, for instance, one-fourth of the value of the flesh, if the flesh can be used, three-quarters if it is unfit for use. For the present, this compensation only to be given to such owners as combat tuberculosis by rational applications of tuberculin in their herds (after the method described). If it is possible, at present, to carry through such a motion is doubtful, but I consider the step to be absolutely in the right direction, as the chief point is to induce the proprietor to part with these animals that are the greatest sources of the continued spreading of the disease. Fortunately, the knowledge of this matter has already penetrated so far that the number of such animals has considerably decreased on Danish farms.

8. AS TO THE ADVANTAGES WHICH WILL ACCRUE FROM THE SUPPRESSION OF TUBERCULOSIS AMONG CATTLE.

On this point I can be very short. Though there cannot be laid stress enough on the fact that tuberculosis in cattle is often a very innocent disease which does not menace the life of the animal or diminish the worth of its products, and that there is no cause to be too much frightened by the results given in almost all countries by the application of tuberculin on a large scale, that shows the disease to

have spread far wider than any one would formerly have believed; yet on the other hand, it is quite evident that *tuberculosis is one of those scourges which cause the greatest harm to the farmer.* The number of animals that perish by it or have to be slaughtered in bad condition is so great that a regard for his own economic interest should alone suffice to strongly interest the farmer in rooting out this scourge. The growing claims which in view of the hygiene of man are almost everywhere put to the soundness of meat, milk and milk produce, render this still more necessary for him. No doubt these claims may be sometimes exaggerated, especially regarding the meat, but the movement exists and the farmer, like every other manufacturer must have an open ear to the claims of the times. And the augmented confidence in the soundness of its animal products which must follow earnest efforts to combat tuberculosis of the cattle, cannot fail to be advantageous to every country.